GeoSyntec Consultants

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4 April 1996

Mr. R. Neil Davies, P.E.
GeoSyntec Consultants
1100 Lake Hearn Drive, Suite 200
Atlanta, Georgia 30342

Subject: Final Report - Laboratory Test Results
Bailey Superfund Site
Pit B Pre-Design Study

Dear Mr. Davies:

GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia, is pleased to present the attached final test results (Table 1 and Figures 1 through 5) for the above referenced project. A blank shown on the table or the figures indicates that the test was not performed, the parameter is not applicable, or that the test resulted in insufficient data to report the designated parameter. Attachment A presents the general information pertinent to the testing program, and the policy of GeoSyntec regarding the limitations and use of the test results.

The Geomechanics and Environmental Laboratory appreciates the opportunity to provide testing services for this project. Should you have any questions regarding the attached test results or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

James M. Stalcup, E.I.T.
Assistant Program Manager
Special Testing

Nader S. Rad, Ph.D., P.E.
Laboratory Director

Attachment

GE3913/GEL96035

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

BAILEY SUPERFUND SITE
PIT B PRE-DESIGN STUDY

Client Sample ID	Lab Sample No.	As-Received Moisture Content (%)	Grain Size			Atterberg Limits ASTM D 4318			Soil Classification ASTM D 2487	Compaction ASTM D 698			Hydraulic Conductivity ASTM D 5084			
			Percent Passing #200 Sieve ASTM D 1140 (%)	ASTM D 422						Max. Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Figure No.	Test Specimen Initial Conditions			Hydraulic Conductivity (cm/s)
				Sieve Figure No.	Hydrom. Figure No.	LL (%)	PL (%)	PI (-)					Dry Unit Weight (pcf)	Moisture Content (%)	Consolidation Pressure (psi)	
A1	E96C05	27.1	80.5	1		45	19	26	CL - Lean Clay with Sand							
B2	E96C06	41.8	69.6	2		42	20	22	CL - Sandy Lean Clay							
	E96C07	30.8											85.8	30.8	5.0	9.0E-9
D1	E96C08	46.1	97.8	3		53	20	33	CH - Fat Clay							
	E96C09	38.6											83.7	38.6	5.0	1.2E-8
E1	E96C10	42.9	95.8	4		62	26	36	CH - Fat Clay							
F2	E96C11	26.9	95.7	5		49	29	20	ML - Silt							

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Geomechanics and Environmental Laboratory
Atlanta, Georgia

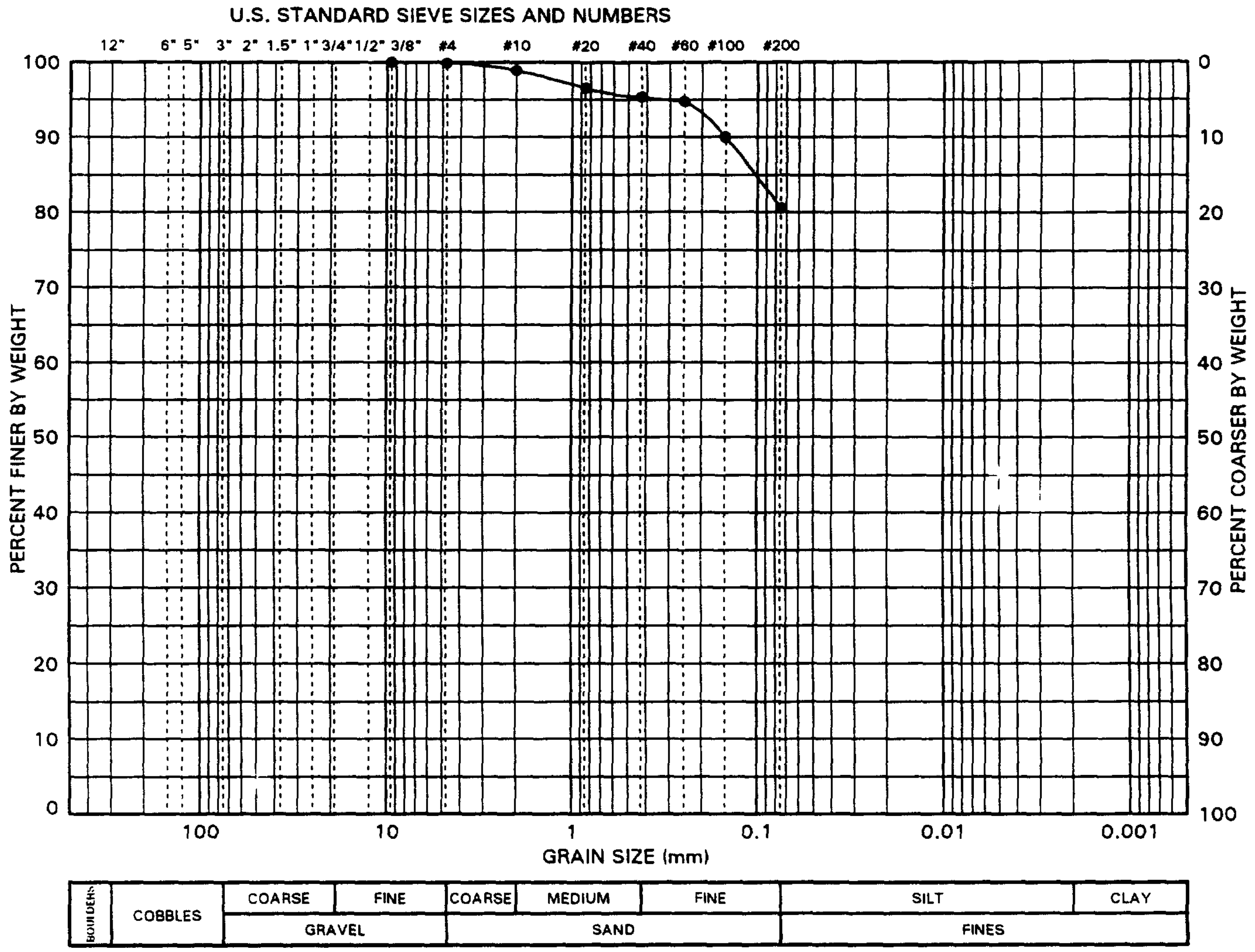
FIGURE 1

PROJECT: BAILEY SITE
PROJECT NO.: GE3913
DOCUMENT NO.: GEL96035

GS FORM: 4PS2 04/02/96

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318



SITE SAMPLE ID	A1	LIQUID LIMIT (%)	45	SOIL FRACTIONS: GRAVEL (%)	0.1
LAB. SAMPLE NO.	E96C05	PLASTIC LIMIT (%)	19	SAND (%)	19.4
SAMPLE DEPTH (ft)		PLASTICITY INDEX	26	FINES (%)	80.5
SOIL CLASSIFICATION: CL - Lean Clay with Sand				SILT (%)	
				CLAY(%)	
				COEFF. UNIFORMITY (Cu)	
				COEFF. CURVATURE (Cc)	

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
75	50	37.5	25	19	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	100	100	99	97	95	95	90	81					

NOTES:

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Geomechanics and Environmental Laboratory
Atlanta, Georgia

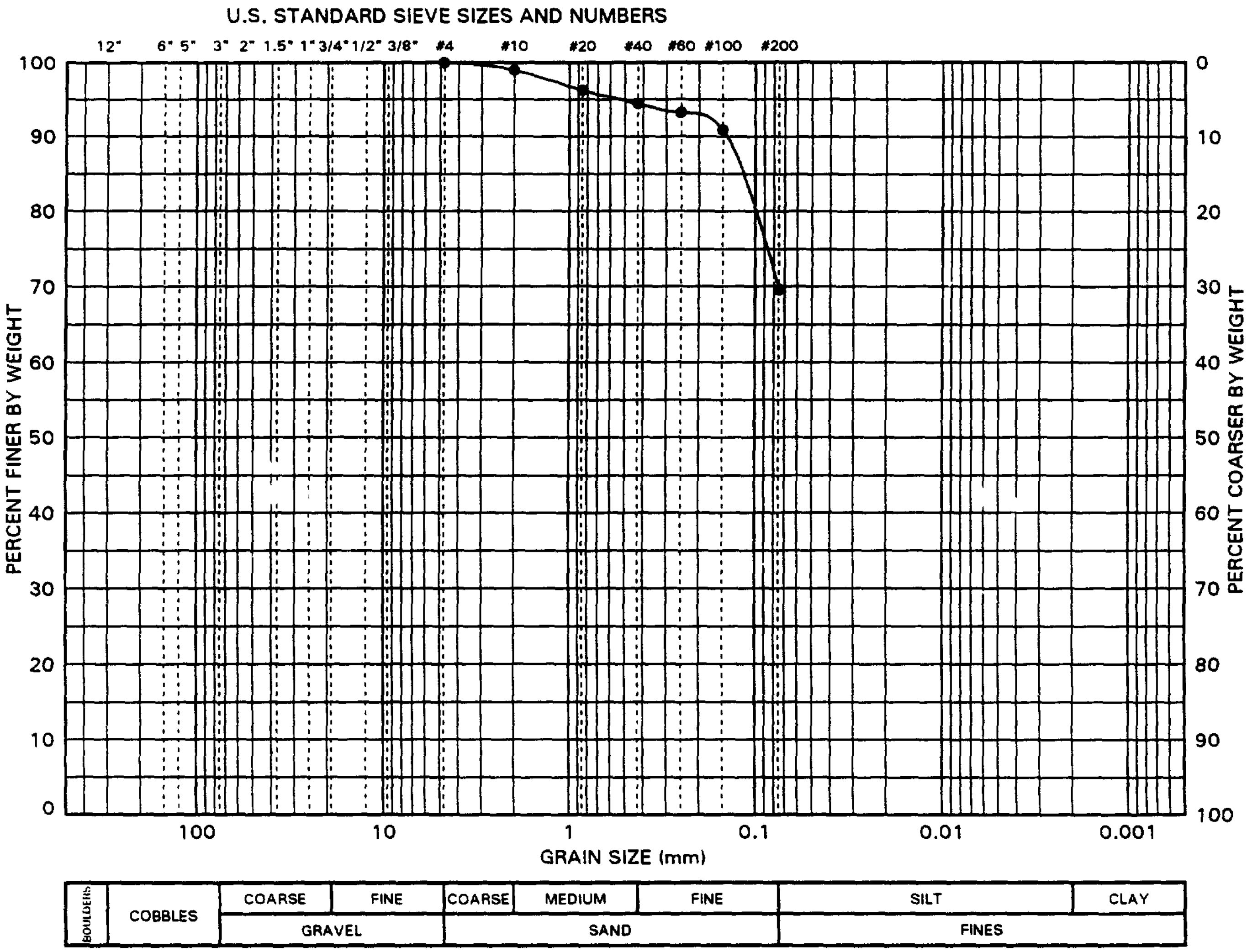
FIGURE 2

PROJECT: BAILEY SITE
PROJECT NO.: GE3913
DOCUMENT NO.: GEL96035

GS FORM: 4PS2 04/02/96

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318



SITE SAMPLE ID	B2	LIQUID LIMIT (%)	42
LAB. SAMPLE NO.	E96C06	PLASTIC LIMIT (%)	20
SAMPLE DEPTH (ft)		PLASTICITY INDEX	22

SOIL CLASSIFICATION:
CL - Sandy Lean Clay

SOIL FRACTIONS	
GRAVEL (%)	0.0
SAND (%)	30.4
FINES (%)	69.6
SILT (%)	
CLAY(%)	
COEFF. UNIFORMITY (Cu)	
COEFF. CURVATURE (Cc)	

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
PERCENT PASSING SIEVE SIZES (mm)																		
75	50	37.5	25	19	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	100	100	99	96	94	93	91	70					

NOTES:

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Atlanta, Georgia

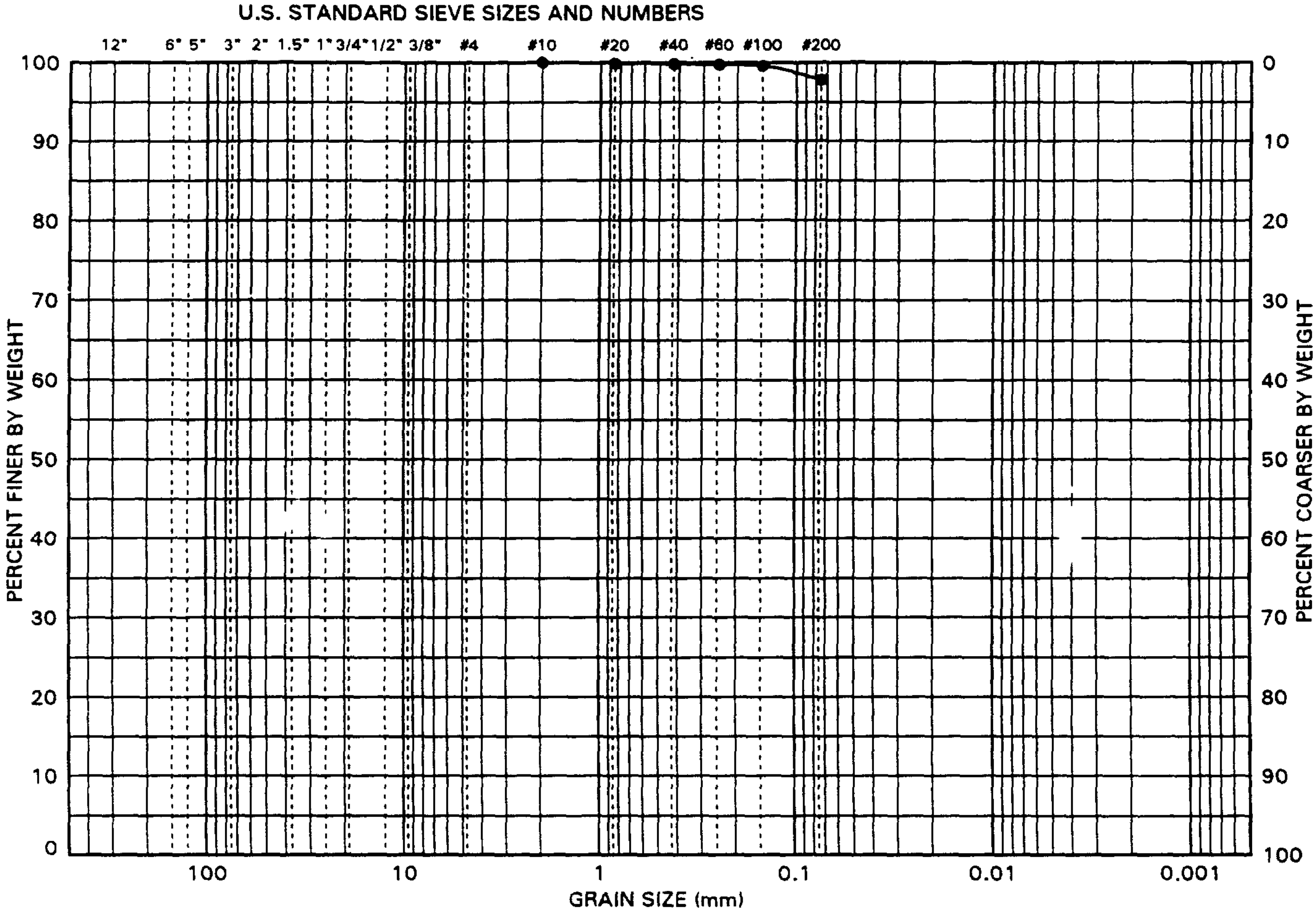
FIGURE 3

PROJECT: BAILEY SITE
PROJECT NO.: GE3913
DOCUMENT NO.: GEL96035

GS FORM: 4PS2 04/02/96

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318



BOULDERS	COBBLES	COARSE	FINE	COARSE	MEDIUM	FINE	SILT	CLAY
		GRAVEL		SAND			FINES	

SITE SAMPLE ID	D1	LIQUID LIMIT (%)	53	SOIL FRACTIONS: GRAVEL (%)	0.0
LAB. SAMPLE NO.	E96C08	PLASTIC LIMIT (%)	20	SAND (%)	2.2
SAMPLE DEPTH (ft)		PLASTICITY INDEX	33	FINES (%)	97.8
SOIL CLASSIFICATION: CH - Fat Clay				SILT (%)	
				CLAY(%)	
				COEFF. UNIFORMITY (Cu)	
				COEFF. CURVATURE (Cc)	

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
PERCENT PASSING SIEVE SIZES (mm)														PARTICLE DIAMETER (mm)				
75	50	37.5	25	19.	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	100	100	100	100	100	100	100	98					

NOTES:

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Atlanta, Georgia

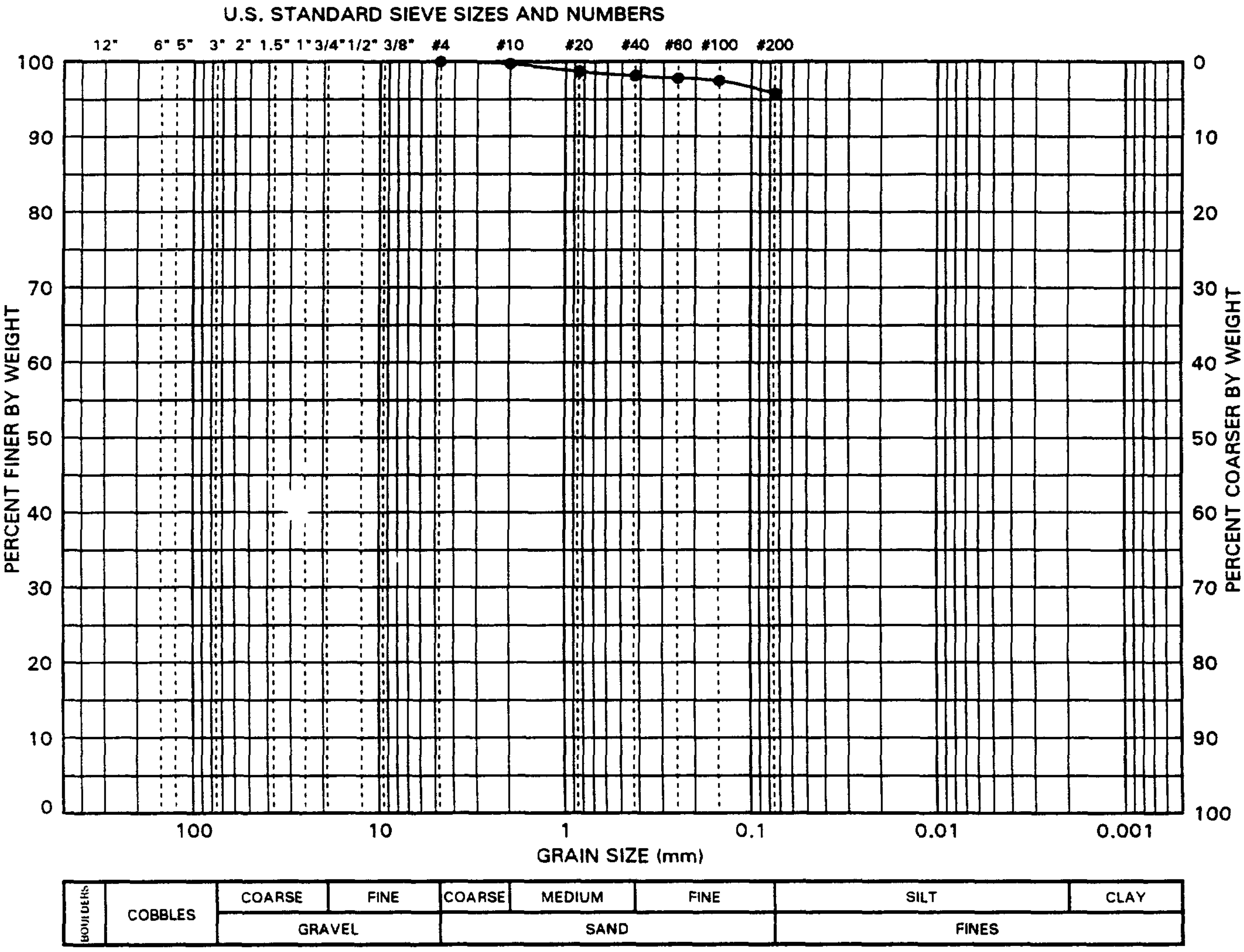
FIGURE 4

PROJECT: BAILEY SITE
PROJECT NO.: GE3913
DOCUMENT NO.: GEL96035

GS FORM: 4PS2 04/02/96

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318



SITE SAMPLE ID	E1	LIQUID LIMIT (%)	62
LAB. SAMPLE NO.	E96C10	PLASTIC LIMIT (%)	26
SAMPLE DEPTH (ft)		PLASTICITY INDEX	36

SOIL CLASSIFICATION:
CH - Fat Clay

SOIL FRACTIONS	
GRAVEL (%)	0.0
SAND (%)	4.2
FINES (%)	95.8
SILT (%)	
CLAY(%)	
COEFF. UNIFORMITY (Cu)	
COEFF. CURVATURE (Cc)	

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
PERCENT PASSING SIEVE SIZES (mm)																		
75	50	37.5	25	19	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	100	100	100	99	98	98	98	96					

NOTES:

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Atlanta, Georgia

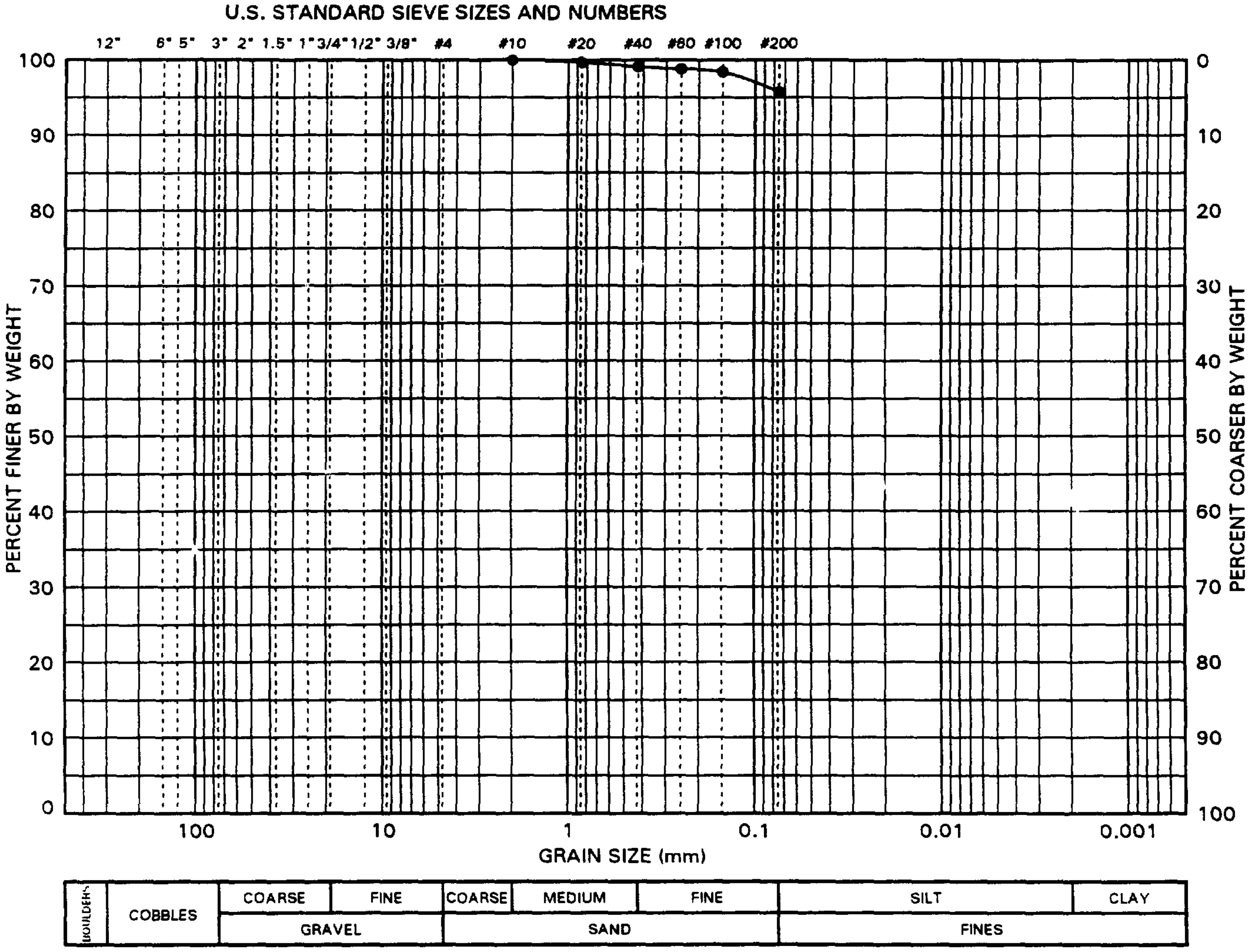
FIGURE 5

PROJECT: BAILEY SITE
PROJECT NO.: GE3913
DOCUMENT NO.: GEL96035

GS FORM: 4PS2 04/02/96

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487 D 3042 AND D 4318



SITE SAMPLE ID	F2	LIQUID LIMIT (%)	49	GRAVEL (%)	0.0
LAB. SAMPLE NO.	E96C11	PLASTIC LIMIT (%)	29	SAND (%)	4.3
SAMPLE DEPTH (ft)		PLASTICITY INDEX	20	FINES (%)	95.7
SOIL CLASSIFICATION: ML - Silt				SILT (%)	
				CLAY(%)	
				COEFF. UNIFORMITY (Cu)	
				COEFF. CURVATURE (Cc)	

SOIL FRACTIONS

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
PERCENT PASSING SIEVE SIZES (mm)																		
75	50	37.5	25	19	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	100	100	100	100	99	99	98	96					

NOTES:

ATTACHMENT A

Sample Identification, Handling, Storage and Disposal

Laboratory Test Standards

Application of Test Results

SAMPLE IDENTIFICATION, HANDLING, STORAGE AND DISPOSAL

Test materials were sent to GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia by the client or its representative(s). Samples delivered to the laboratory were identified by client sample identification (ID) numbers which had been assigned by representative(s) of the client. Upon being received at the laboratory, each sample was assigned a laboratory sample number to facilitate tracking and documentation.

Based on the information provided to GeoSyntec by the client or its representative(s) and, when applicable, procedural guidelines recommended by an industrial hygiene consultant, the following Occupational Safety and Health Administration (OSHA) level of personal protection was adopted for handling and testing of the test materials:

[ ] test materials were not contaminated, no special protection measures were taken;
[X] level D
[ ] level C
[ ] level B

In accordance with the health and safety guidelines of GeoSyntec, contaminated materials are stored in a designated containment area in the laboratory. Non-contaminated materials are stored in a general storage area in the laboratory.

GeoSyntec Geomechanics and Environmental Laboratory will continue storing the test materials for a period of 30 days from the date of this report or a year from the time that the samples were received, which ever is shorter. Thereafter: (i) contaminated materials will be returned to the client or its designated representative(s); and (ii) the materials which are not contaminated will be discarded unless long-term storage arrangements are specifically made with GeoSyntec Geomechanics and Environmental Laboratory.

LABORATORY TEST STANDARDS

At the request of the client, the laboratory testing program was performed utilizing the guidelines provided in the following test standards:

[X] **moisture content** - American Society for Testing and Materials (ASTM) D 2216 "*Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures*";

[ ] **moisture content** - ASTM D 4643 "*Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Method*";

[X] **particle-size analysis** - ASTM 422, "*Standard Method for Particle-Size Analysis of Soils*";

[X] **percent passing No. 200 sieve** - ASTM D 1140, "*Standard Test Method for Amount of Material in Soil Finer Than No. 200 (75 microns) sieve*";

[X] **Atterberg limits** - ASTM D 4318, "*Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*";

[X] **soil classification** - ASTM D 2487, "*Standard Test Method for Classification of Soils for Engineering Purposes*";

[ ] **soil pH** - ASTM D 4972, "*Standard Test Method for pH of Soils*";

[ ] **soil pH** - United States Environmental Protection Agency (USEPA) SW-846 Method 9045, Revision 1, 1987, Standard Test Method for Measurement of "*Soil pH*";

[ ] **specific gravity** - ASTM D 854, "*Standard Test Method for Specific Gravity of Soils*";

[ ] **carbonate content** - ASTM D 3042, "*Standard Method for Insoluble Residue in Carbonate Aggregates*";

[ ] **soundness** - ASTM C 88, *"Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate"*;

[ ] **loss-on-ignition (LOI)** - ASTM D 2974, *"Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"*;

[ ] **standard Proctor compaction** - ASTM D 698, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop"*;

[ ] **modified Proctor compaction** - ASTM D 1557, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop"*;

[ ] **maximum relative density** - ASTM D 4253, *"Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table"*;

[ ] **minimum relative density** - ASTM D 4254, *"Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"*;

[ ] **mass per unit area** - ASTM D 3776, *"Standard Test Method for Mass Per Unit Area (weight) of Woven Fabric"*;

[ ] **thickness measurement** - ASTM D 1777, *"Standard Test Method for Measuring Thickness of Textile Materials"*;

[ ] **free swell** - United States Pharmacopeia National Formulary (USP-NF) XVII, *"Swell Index of Clay"*;

[ ] **fluid loss** - American Petroleum Institute (API)-13B, *"Section 4, Bentonite"*;

[ ] **marsh funnel** - API-13B, *"Section 4, Field Testing of Oil Mud Viscosity and Gel Strength"*;

[ ] **pinhole dispersion** - ASTM D 4647, *"Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test"*;

[ ] **gradient ratio** - ASTM D 5101, *"Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio"*;

[ ] **hydraulic conductivity ratio** - Draft ASTM D 35.03.91.01, *"Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing"*;

[ ] **hydraulic transmissivity** - ASTM D 4716, *"Standard Test Method for Constant Head Hydraulic Transmissivity (In-plane flow) of Geotextiles and Geotextile Related Products"*;

[ ] **one-dimensional consolidation** - ASTM D 2435, *"Standard Test Method for One-Dimensional Consolidation Properties of Soil"*;

[ ] **one-dimensional swell/collapse** - ASTM D 4546, *"Standard Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils"*;

[ ] **unconfined compressive strength (UCS)** - ASTM D 2166, *" Standard Test Method for Unconfined Compressive Strength of Cohesive Soil"*;

[ ] **triaxial compressive strength ($\overline{\text{ICU}}$)** - ASTM D 4767, *"Standard Test Method for Triaxial Compression Test on Cohesive Soils"*;

[ ] **triaxial compressive strength (UU)** - ASTM D 2850, *"Standard Test Method for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression"*;

[ ] **rigid wall constant head hydraulic conductivity** - ASTM D 2434, *"Standard Test Method for Permeability of Granular Soils (Constant Head)"*;

[X] **flexible wall falling head hydraulic conductivity** - ASTM D 5084, "*Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*";

[ ] **flexible wall falling head hydraulic conductivity** - U. S. Army Corp of Engineers; EM-1110-2-1906, "*Standard Test Method for Permeability Tests, Appendix VII*";

[ ] **index flux of GCL** - proposed ASTM method rough draft # 1, 6/18/94, "*Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter*";

[ ] **flexible wall falling head hydraulic conductivity** - Geosynthetic Research Institute (GRI) GCL-2, "*Standard Test Method for Permeability of Geosynthetic Clay Liners (GCLs)*";

[ ] **permeability/compatibility** - USEPA Method 9100, SW-846, Revision 1, 1987, Standard Test Method for Measurement of "*Saturated Hydraulic Conductivity, Saturated Leachate Conductivity and Intrinsic Permeability*";

[ ] **capillary-moisture** - ASTM D 2325, "*Standard Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus*";

[ ] **capillary-moisture** - ASTM D 3152, "*Standard Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus*" and

[ ] **paint filter liquids** - USEPA Method 9095, SW-846, Revision 1, 1987, "*Paint Filter Liquids Test*".

APPLICATION OF TEST RESULTS

The reported test results apply to the field materials inasmuch as the samples sent to the laboratory for testing are representative of these materials. This report applies only to the materials tested and does not necessarily indicate the quality or condition of apparently identical or similar materials. The testing was performed in accordance with the general engineering standards and conditions reported. The test results are related to the testing conditions used during the testing program. As a mutual protection to the client, the public, and GeoSyntec, this report is submitted and accepted for the exclusive use of the client and upon the condition that this report is not used, in whole or in part, in any advertising, promotional or publicity matter without prior written authorization from GeoSyntec.

APPENDIX D

PIT B WASTE CONDITIONING STUDY

Prepared for

Bailey Site Settlors Committee
c/o Parsons Engineering Science, Inc.
9906 Gulf Freeway, Suite 100
Houston, Texas

TECHNICAL MEMORANDUM
PIT B WASTE CONDITIONING STUDY

BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Prepared by

GEOSYNTEC CONSULTANTS
1100 Lake Hearn Drive, NE, Suite 200
Atlanta, Georgia 30342

Project Number GE3913-204

May 1996

TABLE OF CONTENTS

LIST OF TABLES

1. TERMS OF REFERENCE

This document has been prepared by GeoSyntec Consultants, Atlanta, Georgia (GeoSyntec) on behalf of the Bailey Site Settlors Committee (BSSC) to present the results of the bench-scale waste conditioning study conducted on waste present in Pit B at the Bailey Superfund Site, located in Orange County, Texas. The purpose of the waste conditioning study was to evaluate the technical feasibility and effectiveness of different waste conditioning techniques at reducing reactive sulfide levels that were reported in the Pit B waste.

2. STUDY OBJECTIVE

The background of and reasons for conducting the Pit B Pre-design Study (PDS) are presented in the main body of the Pit B PDS Report. The objective of the waste conditioning study is to evaluate (i) the likely source of reactive sulfides that were found in the collected samples of Pit B waste; and (ii) the types of waste conditioning required to reduce the levels of reactive sulfide present (if any) in the Pit B waste stream to less than the EPA Interim Guidance level of 500 mg/kg. The reagents tested were lime, ferric chloride ($FeCl_3$) plus lime, and hydrogen peroxide (H_2O_2) plus lime. The rationale for the selection of these specific reagents is summarized in Section 3.1. Bulk samples of waste were collected from Pit B in the areas thought to contain the highest concentrations reactive sulfide (i.e., up to 1,600 mg/kg reactive H_2S based on results of the PDS sampling events) were collected for evaluation during the waste conditioning study. Varying dosage rates of the reagents considered for the waste conditioning study were evaluated in order to evaluate the lowest dosage possible to reduce the concentration of reactive sulfide. The contributions of all deactivation mechanisms, including dilution, oxidation, precipitation, and pH adjustment/solidification to the disappearance of reactive sulfide were evaluated during the course of this study.

3. EXPERIMENTAL PROTOCOL/RATIONALE

3.1 Deactivation Mechanisms

Sulfide is a regulated constituent under the Resource Conservation and Recovery Act (RCRA) because of its toxicity. Wastes containing sulfide are regulated under RCRA as reactive (D003 waste code) wastes if, at pH values between 2 and 12, the waste will release toxic amounts of sulfide as H_2S gas. The generation of H_2S can be precluded by alkaline pH adjustment or by removing the total reactive sulfide from the waste stream. The latter procedure can be achieved by oxidizing the sulfide present in the waste to sulfate, a relatively non-toxic form of sulfur, in the presence of an oxidizing agent or by precipitation of sulfide as an insoluble compound. The following sections describe the chemical processes evaluated during the waste conditioning study.

3.1.1 pH Adjustment

In aqueous solutions, such as those present in the Pit B waste, soluble sulfide anions exist in pH-dependent forms, as demonstrated by the chemical equilibria presented below:

$$\begin{array}{ccccc} S^{2-} & \xleftrightarrow{H^+} & HS^- & \xleftrightarrow{H^+} & H_2S\uparrow \\ \textit{High pH} & & & & \textit{Low pH} \end{array}$$

In acidic conditions, in the absence of chelating (binding) agents, sulfide will exist as hydrogen sulfide gas (H_2S). Similarly, in alkaline, non-chelating conditions, sulfide will exist as the soluble sulfide anion (S^{2-}). Since reactive sulfide is defined as that sulfide which will be released to the atmosphere as hydrogen sulfide gas (H_2S) between pH 2 and 12, any agent which increases the alkalinity of the material (by increasing its pH), could mitigate the emission of H_2S.

A common industrial reagent used for this purpose is lime (calcium oxide, CaO). Lime increases the pH of an aqueous solution by the following chemical reaction.

$$CaO + H_2O \longleftrightarrow Ca^{2+} + 2OH^-$$

Thus, when lime is added to the waste, the pH is raised, the sulfide anion (S^{2-}) is predominantly formed, and the generation of H_2S is precluded.

3.1.2 Oxidation

A common industrial chemical that has been employed as an oxidizing agent is hydrogen peroxide, H_2O_2. Hydrogen peroxide oxidizes soluble sulfide to sulfate primarily by the following reaction.

$$8H_2O_2 + S^{2-} \rightleftarrows SO_4^{2-} + 8H_2O + 2O_2$$

Stoichiometrically, an 8:1 H_2O_2:S^{2-} ratio is required to completely oxidize sulfide to sulfate. This is a relationship postulated based on the absence of any other reactive species which may also consume the H_2O_2 added. As this is obviously not the case in the Pit B waste material (i.e., there are other compounds, principally organics which will be oxidized by H_2O_2 addition), in the waste conditioning study, a stoichiometric relationship of greater than 8:1 H_2O_2:S^{2-} will be added as an upper limit for H_2O_2 addition. Once formed, sulfate will not generate H_2S unless exposed to a reducing agent. Thus, the waste has been deactivated with regard to sulfide reactivity.

Because the only form of peroxide readily available for the waste conditioning study was 3% H_2O_2, a substantial increase in the moisture content of the waste was caused by the addition of a sufficient quantity of the H_2O_2 solution to oxidize the known quantities of sulfide present (detected at concentrations up to 1,600 mg/kg). While the concentration of the H_2O_2 that would be used in the full-scale application of this technique will be much higher (approximately 30%) than that observed in the waste conditioning study, a similar increase in moisture content can be expected. In anticipation of this problem, the treated material will be stabilized with lime, for the dual purpose of waste solidification and also to raise the pH of the treated material, thus altering the state of any unreacted sulfide to the sulfide anion (S^{2-}), precluding the formation of H_2S.

3.1.3 Precipitation

The most effective agents for sulfide precipitation are generally metallic cations. A relatively non-toxic metallic cation that has been widely used for this purpose is ferric iron (iron in the +3 valence state). Ferric iron (Fe^{3+}) is commercially available as ferric chloride ($FeCl_3$) and reacts with soluble sulfide by the following reaction.

$$2FeCl_3 + 3S^{2-} \rightleftarrows Fe_2S_3(s) + 6Cl^-$$

The ferric sulfide (Fe_2S_3) precipitated is very insoluble (K_{sp}=1.4 x 10^{-88}), even in the presence of acid. Thus, in a complete reaction, soluble sulfide is removed from solution and will not convert to gaseous H_2S. By the stoichiometry above, $FeCl_3$ reacts with soluble sulfide in a 2:3 ratio. It should also be noted that $FeCl_3$ can also be reduced to ferrous sulfide in the presence of a mild reducing agent, likely to be found in the Pit B waste. That reduction occurs by the reactions given below:

$$Fe^{3+} \xleftrightarrow{e^-} Fe^{2+}$$

The reducing agent in question could be the sulfide itself, being converted to sulfate or another oxidized form of sulfur (e.g., sulfur, sulfite, thiosulfate, etc.). The primary oxidation reaction for sulfide has been discussed previously. If, however, there is sulfide remaining in the presence of ferrous (Fe^{2+}) iron, ferrous sulfide (FeS) can be precipitated by the following reaction.

$$Fe^{2+} + S^{2-} \rightleftarrows FeS(s)$$

Ferrous sulfide is also insoluble in water (K_{sp}=4.9 x 10^{-18}), even in the presence of acid. The degree, if any, to which the oxidation of Fe^{3+} to Fe^{2+} will occur is not known. However, if it does occur, sulfide should be precipitated by a similar mechanism.

Due to the solubility limits of $FeCl_3$ in water, relatively dilute concentrations were used in the waste conditioning study, thus resulting in a substantial increase in the moisture content of the treated waste. Therefore, the iron conditioned material was stabilized with lime for the same reasons as was the H_2O_2 conditioned material.

3.1.4 Dilution

Because external agents were added to the waste for the purposes of treatment, some degree of mass dilution will occur, independent of chemical reactions under consideration. The degree to which reactive sulfide disappearance will occur due to dilution was evaluated during the waste conditioning study by mathematically adjusting the post-conditioning concentrations prior to rendering any conclusions as to waste conditioning effectiveness.

3.2 Experimental Protocol

The procedures implemented for this study are summarized below by conditioning level under consideration. Table 1 provides a listing of all samples collected for the waste conditioning study, their corresponding conditioning level, and the chemical analyses performed on each.

Pretesting

1. Three bulk samples (approximately 40 pounds each) were collected in a five gallon bucket from sampling locations A3, D2, and B3, the most heavily contaminated areas of Pit B with regard to reactive sulfide. These samples were shipped to the GeoSyntec Atlanta Laboratory.

2. Upon arrival, sample D2 was homogenized, subsampled in triplicate, and analyzed for reactive sulfide by SW-846 Chapter 7 Method, and total sulfide by SW Method 9030A. Bulk samples A3 and B3 were sampled (three samples from bulk sample A3; one sample from bulk sample B3) for screening purposes and analyzed for reactive and total sulfide. These bulk samples were held in reserve to evaluate the remainder of the Pit B waste in the event that analysis of the sample from location D2 proved unenlightening.

Experimental Procedures:

Stabilization

1. An aliquot of the original sample (approximately 3000 g in weight) was collected.

2. This aliquot was split into thirds (approximately 1000 g each wet weight).

3. A known amount of lime was added to each aliquot. The amounts of lime added were 15, 25 and 40% reagent:waste final ratios.

4. The solution/waste material was mixed thoroughly and allowed to stand for five minutes.

5. Duplicate subsamples were collected from each concentration of lime added and analyzed for reactive sulfide by SW-846 Chapter 7 Method, total sulfide by SW Method 9030A, pH by SW Method 9045C, paint filter by SW Method 9095, and for moisture content by ASTM Method D 2216.

6. Waste handling and mixing operations were performed under controlled conditions (i.e., in a fume hood). The headspace of the mixing container was monitored with Draeger tubes to detect the generation of H_2S gas.

Iron Precipitation

1. An aliquot of the original sample (approximately 3000 g in weight) was collected.

2. This aliquot was split into thirds (approximately 1000 g each wet weight).

3. Ferric chloride was added to each waste aliquot. The concentrations of $FeCl_3$ added were 6, 15, and 30 g $FeCl_3$ per kg waste; each amount of $FeCl_3$ added was dissolved in 100 ml water. Following $FeCl_3$ addition, the waste was mixed thoroughly and subsequently subsampled in duplicate and analyzed for reactive sulfide by SW-846 Chapter 7 Method, total sulfide by SW Method 9030A, pH by SW Method 9045C, paint filter by SW Method 9095, and for moisture content by ASTM Method D 2216.

4. The remaining conditioned material (after subsample collection) was stabilized with 25% (adjusted weight) lime.

5. The waste material was mixed thoroughly and allowed to stand for five minutes.

6. Duplicate subsamples were collected for each concentration of $FeCl_3$ added and analyzed for reactive sulfide by SW-846 Chapter 7 Method, total sulfide by SW Method 9030A, pH by SW Method 9045C, paint filter by SW Method 9095, and for moisture content by ASTM Method D 2216.

7. Waste handling and mixing operations were performed under controlled conditions (i.e., in a fume hood). The headspace of the mixing container was monitored with Draeger tubes to detect the generation of H_2S gas.

Peroxide Oxidation

1. An aliquot of the original sample (approximately 1000 g in weight) was collected.

2. A total of 9 g of H_2O_2 (300 ml 3% solution) was added to this material. Following H_2O_2 addition, the waste was allowed to stand for five minutes and then it was subsampled in duplicate and analyzed for reactive sulfide by SW-846 Chapter 7 Method, total sulfide by SW Method 9030A, pH by SW Method 9045C, paint filter by SW Method 9095, and for moisture content by ASTM Method D 2216.

3. The H_2O_2 conditioned waste was stabilized with 25% lime (adjusted weight).

4. The solution/waste material was mixed thoroughly and allowed to stand for five minutes.

5. Duplicate subsamples were collected from the H_2O_2 conditioned/lime stabilized material and analyzed for reactive sulfide by SW-846 Chapter 7 Method, total sulfide by SW Method 9030A, pH by SW Method 9045C, paint filter by SW Method 9095, and for moisture content by ASTM Method D 2216.

6. Waste handling and mixing operations were performed under controlled conditions (i.e., in a fume hood). The headspace of the mixing container was monitored with Draeger tubes to detect the generation of H_2S gas.

4. RESULTS

4.1 Visual Results Summary

Generally, the reagents applied mixed fairly well with the waste. Hydrogen sulfide was not emitted from any of the waste samples tested at levels detectable with Draeger tubes. For the replicate waste sample conditioned with H_2O_2, it did not appear as though oxygen was emitted from the material (as O_2 bubbles); a noticeable increase in heat was observed from this replicate when lime was added to it, however.

4.2 Pre-Conditioning Results Summary

All three bulk samples analyzed (A3, B3, and D2) contained reactive sulfide concentrations less than 500 mg/kg prior to initiating the waste conditioning study (Table 2), although bulk sample D2 appeared to contain the highest concentration of reactive sulfide (up to 260 mg/kg; Table 2). Since these results were not consistent with those obtained from previous samples of waste collected from Pit B, samples of the water and sediment overlying the waste at location D3 in Pit B were collected and analyzed for total and reactive sulfides in an attempt to identify the potential source of the reactive sulfides. These data are summarized in Table 2.

4.3 Analytical Results Summary

Table 3 presents the results of chemical analyses performed during the waste conditioning study. Table 4 presents the results of these analyses after adjustment for dilution.

For bulk sample D2, the pre-conditioning sampling concentrations of reactive sulfide ranged from 200 to 260 mg/kg (Table 3). Most of the reactive sulfide data were extremely variable in the conditioned waste samples, exhibiting sampling error rates, when computable, of 84% to 125% (Table 3). The end result of the variability in the data is that any data trends are suspect.

Total sulfide was analyzed to provide an additional level of control on the results obtained from the waste conditioning agents applied. However, since the total sulfide levels in the waste material prior to conditioning were less than post-conditioning total sulfide values (Table 2), and because these values were also less than the reactive sulfide values in the same set of samples (Table 3), conclusions based on the total sulfide data cannot be made. The heterogeneous nature of the waste, as evidenced by the high sampling error rates observed for both total and reactive sulfide measured for both the pre- and post-conditioning waste samples, is the likely reason for this apparent disparity.

Lime conditioning may have reduced the reactive sulfide levels in the Pit B waste samples, although variability in the experimental data precludes a positive determination in this regard. For the 15% addition of lime, the reactive sulfide levels may have been reduced up to 26% (Table 4); for the 25% lime addition, reactive sulfide levels may have been reduced up to 43% (Table 4). However, the enormous variation (113-120%) in the analytical data set (Table 4) suggests that this reduction is not significant. The 40% addition of lime apparently reduced the reactive sulfide levels to non-detect (<50 mg/kg; Table 4). In each case, the conditioned material passed the paint filter test, whereas the pre-conditioned material did not, and the pH of the material was dramatically increased, from a pre-conditioned mean of 6.1 to a post-conditioned mean of 12.4 (all lime application rates; Table 4).

Ferric chloride conditioning mediated a reduction in reactive sulfide levels. The 6 g $FeCl_3$/kg application rate did not cause a significant reduction in reactive sulfide levels (Table 4). A significant reduction (to less than the 50 mg/kg detection limit) was noted for the 15 and 30 g $FeCl_3$/kg application rates, however (Table 4). The pH of the material was reduced (made acidic) by the addition of $FeCl_3$ (reduced to approximately pH 2.5 at a dosage rate of 30 g $FeCl_3$/kg; Table 4), which is not surprising since ferric chloride can act as a Lewis acid. When lime was to the ferric chloride conditioned samples, increases in pH were noted (up to pH 12.5; Table 4). The addition of lime significantly reduced the reactive sulfide levels for the 6 g $FeCl_3$/kg application rate (Table 4); no significant change in reactive sulfide levels in the 15 and 30 g $FeCl_3$/kg application rates due to the subsequent addition of lime was noted, however (Table 4).

Hydrogen peroxide, applied at a rate of 9 g H_2O_2/kg waste, reduced the reactive sulfide levels to less than the detection limit of 50 mg/kg and lowered the pH of the material to 4.9 (Table 4). The addition of lime increased the pH of the hydrogen peroxide treated material to 12.45 without a significant change in reactive sulfide levels (Table 4).

5. DISCUSSION

The levels of reactive sulfide in bulk samples A3 and B3 were less than the interim guidance threshold of 500 mg/kg for both samples analyzed (Table 2). This data coupled with the observed concentrations of reactive sulfide in the D2 sample prior to conditioning suggests both that the tarry waste in Pit B, when excavated using a backhoe or other heavy equipment, does not contain reactive sulfide in a concentration greater than 500 mg/kg and that the reactive sulfide levels obtained in earlier Pit B investigations may have come from sampling artifact or another source. A possible source of reactive sulfide in a marsh environment is the sediment; this possibility was investigated as follows.

While at the Bailey site during the execution of the Sitewide Pre-design Study, GeoSyntec personnel collected samples of the sediment and water in Pit B from location D2. The water sample contained 1.1 mg/L reactive sulfide; the sediment sample contained 800 mg/kg reactive sulfide wet weight; 5700 mg/kg reactive sulfide dry weight (Table 2). It is GeoSyntec's opinion that the marsh sediment on top of Pit B is the source of the reactive sulfide detected in the Pit B samples.

With regard to the waste conditioning study, it can generally be concluded that the addition of lime caused a reduction in the levels of reactive sulfide in the Pit B wastes, although the mechanism by which this reduction occurred (dilution or pH adjustment) as well as the minimum lime dosage rate required are uncertain, due to the heterogeneity of waste material, manifested by huge error rates in the samples collected from it (pre- and post-conditioning). A similar statement can be made for ferric chloride addition. Hydrogen peroxide conditioning appeared to reduce the levels of reactive sulfide, but the mechanism by which this was accomplished (i.e., dilution or sulfide oxidation) is unknown.

6. RECOMMENDATION

Because of the relatively inconclusive nature of the waste conditioning study results, and because of the identification of the marsh sediments as the probable source of the reactive sulfide, GeoSyntec recommends an on-site demonstration of the effectiveness of lime conditioning with a larger sample size to confirm that lime conditioning can be used to reduce the concentration of reactive sulfide to less than 500 mg/kg. The waste conditioning process will also serve to improve the handleability of the waste material. The protocol for this demonstration will be developed and addressed under separate cover.

TABLES

TABLE 1
SAMPLE IDENTIFICATION AND ANALYSES PERFORMED
PIT B WASTE CONDITIONING STUDY
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Level	Sample Name	Analyses Performed				
		Total Sulfide (SW 9030A)	Reactive Sulfide (SW-846, Chapter 7)	pH (SW 9045C)	Moisture (ASTM D2216)	Paint Filter (SW 9095)
Pre-Conditioning	D2	X	X			
	D2	X	X			
	D2	X	X			
15% Lime	D2-S1-1	X	X	X	X	X
	D2-S1-2	X	X	X	X	X
25% Lime	D2-S2-1	X	X	X	X	X
	D2-S2-2	X	X	X	X	X
40% Lime	D2-S3-1	X	X	X	X	X
	D2-S3-2	X	X	X	X	X
Iron (6)	D2-FE1-1	X	X	X	X	X
	D2-FE1-2	X	X	X	X	X
Iron (6) + lime	D2-FE1-S-1	X	X	X	X	X
	D2-FE1-S-2	X	X	X	X	X
Iron (15)	D2-FE2-1	X	X	X	X	X
	D2-FE2-2	X	X	X	X	X
Iron (15) + lime	D2-FE2-S-1	X	X	X	X	X
	D2-FE2-S-2	X	X	X	X	X
Iron (30)	D2-FE3-1	X	X	X	X	X
	D2-FE3-2	X	X	X	X	X
Iron (30) + lime	D2-FE3-S-1	X	X	X	X	X
	D2-FE3-S-2	X	X	X	X	X
H_2O_2 (300)	D2-OX1-1	X	X	X	X	X
	D2-OX1-2	X	X	X	X	X
H_2O_2 (300) + lime	D2-OX1-S-1	X	X	X	X	X
	D2-OX1-S-2	X	X	X	X	X

TABLE 2
BULK SAMPLE PRE-CONDITIONING AND MARSH SEDIMENT DATA
PIT B WASTE CONDITIONING STUDY
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Level	Identification	Sample Name	Analyses and Results Performed				
			Total Sulfide (mg/kg)[a]	Reactive Sulfide (mg/kg)[a]	pH	Moisture (%)	Paint Filter
Pre-Conditioning Pit B Waste	Bulk Sample D2	D2	12	260	6.1	68	Fail
	Bulk Sample D2	D2	11	200	6.1	63	Fail
	Bulk Sample D2	D2	10	200	6.1	68	Fail
	Bulk Sample A3	PRE-1	26	240	5.7	46	Fail
	Bulk Sample A3	PRE-2	38	<50	5.3	41	Fail
	Bulk Sample A3	PRE-3	16	110	5.7	40	Fail
	Bulk Sample B3	B3	33	91	NA[b]	58	NA
D2 Sediment	Sediment from D2	D2-S	9.1	800	7.8	86	NA
D2 Water	Water from D2	D2-W	1.1	<50	7.8	NA	NA

[a] *Units are mg/L for water samples*

[b] *NA, Not Analyzed*

TABLE 3
ANALYTICAL DATA SUMMARY
PIT B WASTE CONDITIONING STUDY
BAILEY SUPERFUND SITE – ORANGE COUNTY, TEXAS

Level	Parameter	Replicate 1	Replicate 2	Replicate 3	Mean[a]	S.E.[a,b]	% Error
Pretreatment	Moisture	68	68	63	66.33	2.04	3%
	pH	6.1	6.1	6.1	6.10	0.00	0%
	Total Sulfide	10	12	11	11.00	0.71	6%
	Reactive Sulfide	200	260	200	220.00	24.49	11%
15% Lime	Moisture	58	58		58.00	0.00	0%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	250	300		275.00	35.36	13%
	Reactive Sulfide	260	<50		142.50	166.17	117%
25% Lime	Moisture	53	55		54.00	1.41	3%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	240	85		162.50	109.60	67%
	Reactive Sulfide	180	<50		102.50	109.60	107%
40% Lime	Moisture	46	46		46.00	0.00	0%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	11	3600		1805.50	2537.81	141%
	Reactive Sulfide	<50	<50		NA[c]	NA	NA
Iron	Moisture	66	64		65.00	1.41	2%
	pH	5.3	5.4		5.35	0.07	1%
	Total Sulfide	34	180		107.00	103.24	96%
	Reactive Sulfide	410	<50		217.50	272.24	125%
Iron (6) + lime	Moisture	55	53		54.00	1.41	3%
	pH	12.4	12.3		12.35	0.07	1%
	Total Sulfide	79	170		124.50	64.35	52%
	Reactive Sulfide	98	<50		61.50	51.62	84%
Iron (15)	Moisture	72	60		66.00	8.49	13%
	pH	4.1	4		4.05	0.07	2%
	Total Sulfide	44	97		70.50	37.48	53%
	Reactive Sulfide	<50	<50		NA	NA	NA
Iron (15) + lime	Moisture	54	56		55.00	1.41	3%
	pH	12.3	12.3		12.30	0.00	0%
	Total Sulfide	120	11		65.50	77.07	118%
	Reactive Sulfide	150	<50		87.50	88.39	101%
Iron (30)	Moisture	61	65		63.00	2.83	4%
	pH	2.6	2.5		2.55	0.07	3%
	Total Sulfide	73	64		68.50	6.36	9%
	Reactive Sulfide	<50	<50		NA	NA	NA
Iron (30) + lime	Moisture	55	56		55.50	0.71	1%
	pH	12.2	12.2		12.20	0.00	0%
	Total Sulfide	180	110		145.00	49.50	34%
	Reactive Sulfide	170	58		114.00	79.20	69%
H_2O_2 (300)	Moisture	59	69		64.00	7.07	11%
	pH	5	4.9		4.95	0.07	1%
	Total Sulfide	170	70		120.00	70.71	59%
	Reactive Sulfide	<50	<50		NA	NA	NA
H_2O_2 (300) + lime	Moisture	64	63		63.50	0.71	1%
	pH	12.4	12.5		12.45	0.07	1%
	Total Sulfide	15	10		12.50	3.54	28%
	Reactive Sulfide	<50	<50		NA	NA	NA

[a] *Mean and standard error calculated using 1/2 the detection limit, when at least one, but not all values were non-detect.*

[b] *S.E., Standard error*

[c] *NA, Not applicable, all values are non-detect.*

TABLE 4
ANALYTICAL DATA SUMMARY
PIT B WASTE CONDITIONING STUDY (ADJUSTED FOR DILUTION)
BAILEY SUPERFUND SITE – ORANGE COUNTY, TEXAS

Level	Parameter	Replicate 1	Replicate 2	Replicate 3	Mean[a]	S.E.[a,b]	% Error
Pretreatment	Moisture	68	68	63	66.33	2.04	3%
	pH	6.1	6.1	6.1	6.10	0.00	0%
	Total Sulfide	10	12	11	11.00	0.71	6%
	Reactive Sulfide	200	260	200	220.00	24.49	11%
15% Lime	Moisture	58	58		58.00	0.00	0%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	288	345		316.25	40.66	13%
	Reactive Sulfide	299	<50		162.00	193.75	120%
25% Lime	Moisture	53	55		54.00	1.41	3%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	300	106		203.13	137.00	67%
	Reactive Sulfide	225	<50		125.00	141.42	113%
40% Lime	Moisture	46	46		46.00	0.00	0%
	pH	12.4	12.4		12.40	0.00	0%
	Total Sulfide	15	5040		2527.70	3552.93	141%
	Reactive Sulfide	<50	<50		NA[c]	NA	NA
Iron (6)	Moisture	66	64		65.00	1.41	2%
	pH	5.3	5.4		5.35	0.07	1%
	Total Sulfide	38	199		118.34	114.18	96%
	Reactive Sulfide	453	<50		239.23	302.97	127%
Iron (6) + lime	Moisture	55	53		54.00	1.41	3%
	pH	12.4	12.3		12.35	0.07	1%
	Total Sulfide	109	235		172.12	88.96	52%
	Reactive Sulfide	135	<50		80.24	78.12	97%
Iron (15)	Moisture	72	60		66.00	8.49	13%
	pH	4.1	4		4.05	0.07	2%
	Total Sulfide	49	108		78.61	41.79	53%
	Reactive Sulfide	<50	<50		NA	NA	NA
Iron (15) + lime	Moisture	54	56		55.00	1.41	3%
	pH	12.3	12.3		12.30	0.00	0%
	Total Sulfide	167	15		91.29	107.42	118%
	Reactive Sulfide	209	<50		117.03	130.15	111%
Iron (30)	Moisture	61	65		63.00	2.83	4%
	pH	2.6	2.5		2.55	0.07	3%
	Total Sulfide	82	72		77.41	7.19	9%
	Reactive Sulfide	<50	<50		NA	NA	NA
Iron (30) + lime	Moisture	55	56		55.50	0.71	1%
	pH	12.2	12.2		12.20	0.00	0%
	Total Sulfide	254	155		204.81	69.92	34%
	Reactive Sulfide	240	82		161.03	111.86	69%
H_2O_2 (300)	Moisture	59	69		64.00	7.07	11%
	pH	5	4.9		4.95	0.07	1%
	Total Sulfide	221	91		156.00	91.92	59%
	Reactive Sulfide	<50	<50		NA	NA	NA
H_2O_2 (300) + lime	Moisture	64	63		63.50	0.71	1%
	pH	12.4	12.5		12.45	0.07	1%
	Total Sulfide	24	16		20.31	5.75	28%
	Reactive Sulfide	<50	<50		NA	NA	NA

[a] *Mean and standard error calculated using 1/2 the detection limit, when at least one, but not all values were non-detect.*
[b] *S.E., Standard error*
[c] *NA, Not applicable, all values are non-detect.*

Prepared for

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TECHNICAL MEMORANDUM SUPPLEMENTAL EAST DIKE AREA AND PIT B SITE INVESTIGATIONS

BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS

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Project Number GE3913-100

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EXECUTIVE SUMMARY

This document has been prepared by GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia, for the Bailey Site Settlors Committee (BSSC) to present the results of the supplemental site investigations performed in the East Dike Area and Pit B of the Bailey Superfund Site, located in Orange County, Texas. This work product is the result of "*Addendum 1 of Sampling and Analysis Plan for Supplemental Site Investigation for Focused Feasibility Study, Revision 1*" (SAP-AD1). GeoSyntec submitted the SAP-AD1 to the U.S. Environmental Protection Agency, Region 6 (USEPA) on 27 October 1995.

East Dike Area

The East Dike Area supplemental site investigation was performed to better define the composition and nature of the waste in this area. Previous investigations and studies in the East Dike Area did not sufficiently characterize the waste (i.e., in terms of waste component types, particle size, heterogeneity, and presence of solidification inhibitors) for an evaluation of the technical feasibility of using in-situ solidification technologies.

The field work consisted of excavating seven test pits in the East Dike Area. The excavation of each test pit was carefully logged and documented to provide an estimation of the gross composition of the waste. Bulk waste samples were obtained at several depths from six of the test pits. The bulk waste samples were hand sorted and sieved to estimate the composition and particle size distribution of the smaller waste fractions.

The laboratory program for this SAP-AD1 involved testing selected waste samples for loss on ignition to estimate the percentage of organic material in the waste. Soil samples collected from beneath the waste were also tested to evaluate certain physical properties that will be used in the evaluation of alternative remedies for the Bailey Superfund Site, and for the development of an alternative design.

Based on the results of the field investigations and laboratory testing program, GeoSyntec concludes that a variety of municipal and industrial wastes were co-disposed in the northern portion of the East Dike Area. These wastes include a high proportion of decomposed municipal solid waste, rubber crumb, and debris (metal, glass, and wood), and have a high organic content (up to 60.5 percent as determined by loss on ignition). This conclusion is significant since USEPA and industry recognize significant difficulties and limitations in solidifying municipal waste, wastes containing a high proportion of debris, and wastes that have a high organic content (greater than one percent total organic content).

The waste in the middle portion of the East Dike Area is comprised of rubber crumb and other rubbery wastes that also have a high organic content (loss on ignition up to 89.3 percent). This waste material was often observed as being a relatively hard mass that was more difficult to excavate than a typical uncemented soil material. In attempts to excavate this material, the backhoe tended to excavate sheet- or block-like pieces of the waste by tearing it from the hard waste mass. The southern portion of the investigated area contains rubber crumb and rubbery wastes that are not as hard as the middle portion of the investigated area.

GeoSyntec has previously reviewed and cited several documents that establish USEPA's position with respect to the solidification of problematic wastes in the "*Technical Memorandum, Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy, Bailey Superfund Site, Orange County, Texas.*"

Based on the USEPA documents, the additional data obtained during the supplemental site investigation, GeoSyntec's evaluation of the in-situ solidification component of the original design, and the findings presented in this report, it is concluded that successful in-situ solidification of the northern and middle portions of the East Dike Area to the specified performance criteria is technically infeasible, given the composition of the waste. In addition, according to the Record of Decision (ROD) for the Bailey Superfund Site, the functions of solidification are to *"reduce the mobility of the wastes and provide strength to support the cap."* Based on the results presented in this report, the wastes in the East Dike Area have adequate strength to support a final cover system and solidification for this purpose is not needed.

Pit B

Following a review of the existing data for the Pit B waste, GeoSyntec concluded that there were not sufficient data to adequately evaluate alternative disposal options for the Pit B waste. Therefore, a supplemental site investigation of Pit B was implemented to collect and analyze samples of the waste.

Based on a statistical evaluation of the analytical data for the Pit B waste samples, benzene is present at hazardous levels in the eastern portion of Pit B when compared to TCLP regulatory levels, as prescribed in 40 CFR §261.24. In addition, benzene in sample G-TP-W-1 was detected at a concentration greater than the universal treatment standard (UTS) for benzene as set in 40 CFR §268.48.

Based on the results of the supplemental site investigation, GeoSyntec recommends that Pit B be considered an isolated "hot spot", consistent with the definition presented in "Presumptive Remedy for CERCLA Municipal Landfill Sites." However, additional investigations are necessary to accurately evaluate the lateral and vertical limits of Pit B and to estimate the volume of waste and affected sediments that exhibit hazardous characteristics.

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1. INTRODUCTION

1.1 Terms of Reference

This document has been prepared by GeoSyntec Consultants, Atlanta, Georgia (GeoSyntec) for the Bailey Site Settlors Committee (BSSC) to present the results of the supplemental site investigation activities performed in the East Dike Area and Pit B of the Bailey Superfund Site, located in Orange County, Texas. This work product is the result of "*Addendum 1 of Sampling and Analysis Plan for Supplemental Site Investigation for Focused Feasibility Study, Revision 1*" [GeoSyntec, 1995a] (SAP-AD1). GeoSyntec submitted the SAP-AD1 to the U.S. Environmental Protection Agency, Region 6 (USEPA) on 27 October 1995.

The supplemental site investigations described in this report were not specifically addressed in the original "*Work Plan for Focused Feasibility Study, Revision 1*" [GeoSyntec, 1995b] (Work Plan), but they were performed to fill data gaps identified following a review of the available data relative to the site. GeoSyntec conducted a detailed review of existing site data as part of Task 3, Review of Site Data, of the Work Plan.

The work described in this report was performed as outlined in the approved SAP-AD1, and in accordance with the specific requirements of the following documents:

- *Sampling and Analysis Plan for Supplemental Site Investigation for Focused Feasibility Study, Revision* 1, [GeoSyntec, 1995c] (SAPSSI) ;

- *Quality Assurance Project Plan* [Harding Lawson Associates (HLA), 1991a] (QAPP), as amended by Appendix A of the SAPSSI;

- *Final Sampling and Analysis Plan* [HLA, 1991b] (SAP-HLA);

- *Health and Safety Plan* [Parsons Engineering Science, Inc. (Parsons ES), 1995] (HASP), and Addenda Number 1 and 2; and

- *Health and Safety Plan* [GeoSyntec, 1995d] (GHASP).

1.2 Project Background

The Bailey Superfund Site is located approximately 3 mi (5 km) southwest of Bridge City in Orange County, Texas. The site was originally part of a tidal marsh near the confluence of the Neches River and Sabine Lake. In the early 1950s, Mr. Joe Bailey constructed two ponds (Pond A and Pond B) at the site as part of the Bailey Fish Camp. The ponds were reportedly constructed by dredging the marsh and piling sediments to form dikes along the northern and eastern limits of Pond A (the North Dike Area and the East Dike Area, respectively). Between the time of construction (1950s) and the spring of 1971, Mr. Bailey used a variety of wastes including industrial wastes, municipal solid waste (MSW), and debris as fill material for these dikes.

In 1984, USEPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986. A remedial investigation (RI) [Woodward-Clyde Consultants, 1987] was completed for the site in October 1987, and a feasibility study (FS) [Engineering-Science, Inc., 1988] was completed in April 1988. The RI concluded that: (i) the site has had no impact on drinking water; and (ii) in the unlikely event that site constituents were to migrate via ground-water flow, it would take over 800 years for them to reach potable ground water. The shallow ground water beneath and adjacent to the site is saline and not suitable for human consumption. The closest public water supply well, located approximately 1.5 mi (2.4 km) northeast of the site, is estimated to be approximately 385 ft (117 m) deep. The nearest municipal water supply wells are located approximately 2.6 mi (4.2 km) northeast of the site and have a reported depth of approximately 585 ft (173 m). There has been no development in the immediate vicinity of the Bailey Superfund Site, nor is it likely to be suitable for future development due to prohibitions against development in wetlands areas. No air emissions above ambient conditions were detected during air monitoring activities conducted during RI field activities.

In the FS report, Engineering-Science recommended in-situ solidification of the on-site waste as the preferred remedy for the site. USEPA selected this remedy in the Record of Decision (ROD) for the site, signed on 28 June 1988. The remediation area comprises the North Dike Area, East Dike Area, and the North Marsh Area. The North Dike Area is approximately 3,000 ft (914 m) long by 130 ft (40 m) wide, and the East Dike Area is approximately 1,200 ft (366 m) long by 220 ft (67 m) wide. Surficial tarry wastes are present in the North Marsh Area which borders the northern side of the North Dike Area. These wastes extend from the edge of the North Dike Area to a distance of up to 150 ft (46 m) into the marsh. The remediation of the North Marsh Area is being addressed separately as an independent removal action that is planned to occur in early 1996.

A remedial design (RD) for the selected remedy was developed by Harding Lawson Associates, Houston, Texas (HLA) and a construction contract for the implementation of the remedial action (RA) was awarded to Chemical Waste Management, Inc. (Chem Waste) in 1992. The RD specified that the on-site waste be solidified to a minimum unconfined compressive strength of 25 psi (172 kPa) and a hydraulic conductivity of not more than 1 x 10^{-6} cm/s. During initial attempts to solidify waste in the East Dike, Chem Waste encountered difficulties attaining the specified physical and hydraulic performance criteria (i.e., unconfined compressive strength and hydraulic conductivity) for the solidified waste. As a result of these difficulties, the RA was eventually suspended in early 1994. Remedial activities that were completed prior to the cessation of work include the construction of a dike around the East Dike Area of the site, and partial solidification of waste within the southern portion of the East Dike Area.

After Chem Waste stopped work, the BSSC retained independent contractors and consultants to perform a pilot study at one location in the East Dike Area to evaluate the feasibility of in-situ solidification with respect to achieving the specified physical and hydraulic performance criteria. The study indicated that in-situ solidification in general conformance with the specified performance criteria could be achieved at that location. The study concluded, however, that to meet the specified performance criteria, conformance testing needed to be based on wet sampling of uncured material, followed by laboratory curing, rather than coring of material cured in-situ (as had initially been performed in accordance with the construction specifications) [McLaren-Hart and Kiber Environmental Services, Inc., 1995]. Importantly, the study did not address the feasibility of solidification in other areas of the site (i.e., the North Dike Area and the northern portions of the East Dike Area). The data and information collected during the RI, RA, and subsequent investigations indicate that the waste in the

North Dike Area is deeper and more heterogeneous than the waste in the area of the pilot study. These data also indicate that wastes in the North Dike Area and northern portions of the East Dike Area include MSW, debris, rubber crumb, and tarry wastes which, based on both USEPA and industry experience, are difficult and expensive to effectively solidify in-situ.

Based on RA activities at the site to date, the BSSC concluded that successful site-wide solidification of waste at the site to the specified physical and hydraulic performance criteria will be, at a minimum, expensive, time consuming, and difficult to implement. Recognizing this fact, USEPA requested that BSSC further evaluate the feasibility of solidification and perform a focused feasibility study (FFS) to identify whether more expedient and effective remedial actions for the site may be available.

1.3 Objectives of the Supplemental Site Investigations

1.3.1 Scope

The supplemental site investigations at the site were performed to: (i) better define the composition and nature of the waste material in the East Dike Area; and (ii) characterize and profile the waste material in Pit B. The objectives of the supplemental site investigations for the East Dike Area and Pit B are discussed below.

1.3.2 East Dike Area

In August 1995, a supplemental site investigation was performed in the North Dike Area of the site to evaluate the composition and nature of the waste material. In general, the waste contains varying amounts of co-disposed industrial waste (tarry materials and rubber crumb) and MSW (decomposed MSW, glass, wood, and metal). The results and evaluation of this investigation are presented in *"Technical Memorandum, Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy, Bailey Superfund Site, Orange County, Texas"* [GeoSyntec, October 1995e] (TM-NDA). Following an evaluation of resultant data, previous work at the site, and USEPA guidance documents, GeoSyntec concluded that implementation of the original design (i.e., in-situ solidification to specified physical and hydraulic performance criteria) is technically infeasible for the North Dike Area due to the widespread presence of co-disposed or problematic wastes. USEPA concurred with this conclusion in a letter dated 31 October 1995.

While evaluating site information presented in the RI, FS, RD, and RA documents, GeoSyntec found references to the presence of co-disposed waste in portions of the East Dike Area that were not solidified by Chem Waste. Summaries of the previous remedial efforts and the in-situ stabilization pilot demonstration for the East Dike Area are presented in Section 2 of the TM-NDA. The area that has been solidified (southern end of the East Dike) contains waste that has been described as "*black cindery waste: saturated soft; some rubbery chunks, no municipal waste noted*" [HLA, 1991c]. In contrast, the middle and northern portions of the East Dike have been described as containing varying amounts of MSW and black cindery waste.

If the waste in the middle and northern portions of the East Dike Area is similar to the North Dike Area waste and contains a significant proportion of tarry materials, rubber crumb, and MSW, effective solidification could prove difficult, and possibly infeasible. Therefore, to proceed with the evaluation of the original design, and to evaluate potential alternative remedies, it was necessary to better define the composition and nature of the waste material in the East Dike Area in a manner consistent with the methods used for the North Dike Area investigation.

The results of the waste composition analysis will be considered in the FFS during the remedial technology and process option screening activities and the detailed analysis of the remedial alternatives.

1.3.3 Pit B

Pit B is located between the North Dike Area and the North Marsh Area in the western portion of the site. The original design required waste material within this area to be capped following in-situ solidification; however, this work has not been performed. As part of the FFS, alternative remedies for the treatment or disposal of the Pit B waste will be evaluated. However, data regarding the chemical characteristics of the Pit B waste are limited. More specifically, prior to the supplemental site investigation, adequate data did not exist that would allow preliminary waste profile sheets to be completed. Waste profile sheets are required to make decisions regarding the technical and regulatory feasibility of off-site disposal (a potential alternative remedy for the Pit B waste), and to obtain cost quotations for disposal. It was therefore necessary to collect additional data to fully characterize the Pit B waste in order to proceed with the FFS activities. The sampling and analytical program for Pit B was designed to provide data suitable for these purposes.

The results of the investigation will be used to evaluate alternative treatment or disposal options for the Pit B waste. The evaluation will consider both the technical and regulatory feasibility of each alternative disposal option.

1.4 Document Organization

The remainder of the technical memorandum is organized as follows.

- The investigation, sampling, and testing procedures used for these supplemental site investigations are included in Section 2.
- The investigation and testing results for these investigations are provided in Section 3.
- An interpretation of the results is included in Section 4.
- References cited in this technical memorandum are provided in Section 5.

2. INVESTIGATION, SAMPLING AND TESTING PROCEDURES

2.1 East Dike Area

2.1.1 Test Pit Excavation and Sampling Procedures

On Monday, 13 November 1995, seven test pits (designated G-TP14 through G-TP20) were excavated in the northern and middle portions of the East Dike Area (north of the previously solidified material). In accordance with the SAP-AD1, test pit excavation activities began in the northern end of the area and proceeded southward. The test pit locations are shown on Figure 1.

The test pits were excavated with a backhoe and were approximately 3 to 4 ft (0.9 to 1.2 m) wide, 10 ft (3 m) long, and between 6.5 to 10 ft (2 to 3 m) deep. The test pits were excavated to a depth at least 1 ft (0.3 m) below the bottom of the waste.

The excavated soil and waste material were placed on plastic sheeting down wind from the excavation. Samples of the waste material and the soil beneath the waste were collected from the backhoe bucket with a shovel as the excavation proceeded. A total of nine bulk waste samples were placed in 5-gallon (18.5-l) plastic buckets for waste characterization analysis. Duplicate waste samples were collected for the nine samples and were placed in 2-gallon (7.4-l) Zip-Lock plastic bags for laboratory testing. In addition, two soil samples were collected from beneath the waste for laboratory testing. A summary of the samples collected from the East Dike Area during this supplemental site investigation is included in Table 1.

The walls of the test pits were logged by a field engineer standing along the rim of the excavations. No one was permitted to enter the excavations. Field personnel logged the details of the excavation and the composition of the excavated waste. Photographs were taken and a videotape recording was made during the excavation process. Observations made during the test pit excavation activities are discussed in Section 3 of this document.

2.1.2 Field Tests

Nine bulk samples or portions of the bulk samples were characterized in the field to evaluate the waste composition for each sample. The following procedures were used to perform this evaluation:

- the weight and volume of each waste characterization sample were recorded on a pre-printed waste characterization form;

- the sample was sorted by particle size using a series of 14-in. (360-mm) diameter sieves with square openings of 1 in. (25 mm), 0.5 in. (12.7 mm), and 0.25 in. (6.4 mm);

- the material remaining on each sieve and passing the 0.25-in. (6.4 mm) sieve was then sorted according to composition; and

- the weight and volume for each composition type and particle size were recorded on the waste characterization forms.

The results of the field tests are presented in Section 3 of this document.

2.1.3 Laboratory Tests

The nine waste duplicate samples and the two soil samples collected from beneath the waste were shipped to the GeoSyntec Consultants Environmental Laboratory in Atlanta, Georgia, for additional tests. Seven waste samples were selected for laboratory testing based on the location, depth, and appearance of the samples. The samples were tested for the following:

- loss on ignition (ASTM D 2947) to estimate organic content;

- percent passing No. 4 U.S. standard sieve size (modified ASTM D 422); and

- moisture content (ASTM D 2216).

The two soil samples were tested for the following:

- percent passing No. 200 U.S. standard sieve size (ASTM D 1140);
- Atterberg limits (ASTM D 4318);
- soil classification (ASTM D 2487); and
- hydraulic conductivity (ASTM D 5084).

The results of these laboratory analyses are presented in Section 3 of this document.

2.2 Pit B

2.2.1 Sample Collection

On Tuesday, 14 November 1995, waste and underlying soil (where possible) samples were collected from four locations within Pit B. Sampling locations were selected to provide approximate uniform coverage of the waste within Pit B. Sampling commenced from the eastern end of the pit, and progressed towards the west. Figure 1 indicates the sampling locations.

Samples were collected by (i) pushing a 3-in. (76-mm) inside diameter PVC pipe approximately 4 to 7 ft (1.2 to 2.1 m) into the waste with a backhoe bucket; (ii) placing a cap on the pipe; (iii) pulling the pipe from the waste with a strap attached to the backhoe bucket; (iv) removing the sample from the pipe; and (v) placing the waste sample into laboratory prepared containers. In general, approximately 1- to 2-ft (0.3- to 0.6-m) long sections of the PVC pipes filled with waste. Each waste sample was labeled, placed in a plastic bubble pack bag, and stored on ice in an insulated cooler for transportation to the analytical laboratory. The waste samples were shipped under chain-of-custody protocols to an analytical laboratory for chemical analyses. The chemical analyses were performed by EcoSys Laboratory Services, Norcross, Georgia.

The underlying soil samples were shipped to the GeoSyntec Consultants Environmental Laboratory, Atlanta, Georgia. No testing has been performed on the underlying soil samples, but laboratory tests may be performed during the preparation of the FFS.

2.2.2 Sample Identification

Each sample was given a unique identification number that designated the following:

- sampling organization - GeoSyntec (G)
- general area of the site - test pit (TP) or Pit B (PB)
- sample matrix - waste (W) or soil/sediment (S); and
- location/numerical designation - where duplicates were collected, samples were labeled with an extension of "DUP".

For example, a sample with an identification code of G-PB-W-3 would indicate a waste sample collected by GeoSyntec in Pit B at location 3.

2.2.3 Sample Analysis

Table 2 presents an analysis summary for the samples collected from Pit B on 14 November 1995. The following analyses, with the representative analytical methods, were used on one or more samples (USEPA test methods given in parenthesis):

- metals, total and TCLP (Method 6010);
- SVOC, total and TCLP (Method 8270);
- VOC, total and TCLP (Method 8260);
- reactive cyanide (Method 7.3.3.2);

- reactive sulfide (Method 7.3.4.1);
- waste Profile - corrosivity (Method 150.1); and
- waste profile - ignitability (Method 1010).

3. INVESTIGATION AND TESTING RESULTS

3.1 East Dike Area

3.1.1 Test Pit Observations

The following observations were made during the excavation of each test pit:

- overburden thickness;
- depth to bottom of waste;
- depth to ground water;
- description of soil beneath the waste;
- depth to bottom of test pit;
- waste composition (relative percentages of glass, metal, decomposed MSW and soil mixture, rubber crumb and soil mixture, rubber crumb, thick rubbery sludge and other wastes were estimated); and
- general nature of the waste (soft, hard, etc.).

In general, based on visual observations made during the test pit excavations, the waste contains varying amounts of the materials listed below (approximated maximum percentages for any one stratum in any one test pit are also listed):

- broken and unbroken glass bottles: up to 20 percent;
- metal: up to 20 percent;
- wood and tree limbs: up to 25 percent;

- bricks: up to 10 percent;

- decomposed MSW and soil mixture: up to 80 percent;

- rubber crumb and soil mixture: up to 100 percent;

- rubber crumb: up to 100 percent; and

- thick rubbery sludge: up to 100 percent.

In addition, a 15-ft (4.6-m) long, 1-ft (0.3-m) diameter telephone pole was excavated from test pit G-TP15 from a depth of approximately 3.0 to 4.0 ft (0.9 to 1.2 m) below the ground surface. The waste type observed at tnis depth was rubber crumb.

The excavated materials for the three northern-most tests pits, G-TP-14 through G-TP-16, included the following wastes (from ground surface downward):

- approximately 0.5 to 1.0 ft (0.15 to 0.3 m) of cover soil;

- approximately 1.0 ft (0.3 m) of rubber crumb and soil mixture;

- approximately 3.0 to 5.0 ft (0.9 to 1.5 m) of rubber crumb; and

- approximately 1.5 to 2.5 ft (0.5 to 0.7 m) of MSW and soil mixture.

The waste in the four remaining test pits, G-TP17 through G-TP20, contained approximately 3.0 to 7.0 ft (0.9 to 2.1 m) of rubber crumb. No MSW was observed in these test pits.

Based on the observation of materials removed from the test pits, the rubber crumb in test pits G-TP17 through G-TP19 was often present as a relatively hard mass that was more difficult to excavate than a typical uncemented soil material. In attempting to excavate this material, the backhoe tended to remove sheet- or block-like pieces of the waste by tearing it from the hard waste mass. In addition, the tearing action of the waste could be heard while the waste was being excavated. The rubber crumb in test pit G-TP20 was not as hard as the rubber crumb in test pits G-TP17 through G-TP19.

The observations for each test pit together with sample descriptions and photographs of the excavated waste are included in Appendix A of this document.

3.1.2 Field Tests

Table 3 summarizes the results of the waste characterization analyses performed on the nine bulk samples collected from the test pits. The characterized waste samples contained varying amounts of the waste types listed below (maximum weight percentages for any one sample are also listed):

- broken glass: up to 16 percent;
- metal: up to 5 percent;
- decomposed MSW and soil mixture: up to 80 percent;
- rubber crumb: up to 100 percent;
- thick rubbery sludge: up to 100 percent;
- wood: up to 8 percent;
- brick: up to 17 percent;
- stones: up to 11 percent; and
- sea shells: up to 11 percent.

The above field test results are based on sorting each fraction of the waste sample and therefore are slightly different to the results reported by visual observation.

Figures 2 and 3 present waste composition summary charts for each test pit sample. The data in Table 3 were used to prepare these charts.

3.1.3 Laboratory Tests

The data report for the laboratory tests for the waste and soil samples is included as Appendix B of this document. As shown in Table 1 of Appendix B, the waste samples have the following characteristics:

- moisture content (ASTM D 2216): 27.2 to 110.2 percent with an average of 64.3 percent;
- percent passing No. 4 U.S. standard sieve size (modified ASTM D 422): 17.8 to 75.0 percent with an average of 48.9 percent; and
- loss on ignition (ASTM D 2947): 3.2 to 89.3 percent with an average of 45.3 percent.

The results of the testing of soil samples obtained from the bottoms of the test pit excavations are presented as Table 2 of Appendix B. The soil samples had the following characteristics:

- percent passing No. 200 U.S. standard sieve size: 95.4 to 96.0 percent with an average of 95.7 percent;
- Atterberg limits (ASTM D 4318): liquid limit—50 to 67 percent with an average of 58.5 percent; plastic limit—16 to 19 percent with an average of 17.5 percent; plasticity index—34 to 48 percent with an average of 41.0 percent;
- soil classification (ASTM D 2487): lean clay (sample G-TP14-S-1) and fat clay (sample G-TP15-S-1); and

- hydraulic conductivity (ASTM D 5084): 1.8×10^{-8} to 6.5×10^{-9} cm/s with a geometric mean value of 1.1×10^{-8} cm/s.

3.2 Pit B

Tables 4 and 5 present the results of analyses performed on the waste samples collected from Pit B. Only compounds detected above the laboratory detection limit in at least one sample are presented in Table 4. Table 5 presents the maximum value, minimum value, and average concentrations for those compounds presented in Table 4, together with applicable regulatory limits. Copies of the laboratory data sheets for the Pit B analytical results are included as Appendix C of this document.

4. INTERPRETATION OF RESULTS

4.1 East Dike Area

4.1.1 Summary of Results

As shown on Figure 4, the total waste composition by weight for the samples that were characterized is as follows:

- 43 percent rubber crumb;
- 31 percent decomposed MSW and soil mixture;
- 12 percent thick rubbery sludge;
- 7 percent glass (broken bottles);
- 2 percent metal; and
- 5 percent brick, wood, stones, and sea shells.

Based on the visual observations of the excavated waste (presented in Section 3 of this document), the waste has a higher quantity of metal, wood, and glass than indicated by the waste sample characterization results given above. This difference is attributed to the limitations of sorting a sample that is relatively small when compared to: (i) the quantity of material excavated from the test pit; and (ii) the sizes of the pieces of waste that were excavated from the pits but, due to their sizes, not included in the sampling and sorting exercise. For example, several test pits had pieces of wood that were larger than the 5 gallon (18.5-l) sample containers. A piece of wood this size would not be included in the waste characterization sample, but was considered when relative quantity estimates of the waste composition were made based on visual observations. Therefore, the waste sample characterization results are more applicable for describing the portion of the excavated waste that generally has a particle size less than 2 in. (50 mm) in its greatest dimension.

Charts showing the percentages of the particle sizes for the rubber crumb, decomposed MSW and soil mixture, and thick rubbery sludge are included in Figures 5 through 7 of this document. As shown on the charts:

- significant portions of the rubber crumb were greater than 1 in. (25 mm) (49 percent) and less than 0.25 in. (6.4 mm) (39 percent);

- similarly, portions of the decomposed MSW and soil mixture were greater than 1 in. (25 mm) (32 percent) and less than 0.25 in. (6.4 mm) (37 percent); and

- in contrast, a majority of the thick rubbery sludge was less than 0.25 in. (6.4 mm) (92 percent).

The results of the supplemental site investigation for the East Dike Area indicate that a variety of municipal and industrial wastes were co-disposed in the northern portion of the area investigated. As shown on Figure 1, approximately 250 linear ft (76 m) of the northern portion of the East Dike Area contains co-disposed waste.

The observations made during the excavation activities also indicate that the rubber crumb may be present in the middle portions (approximately 350 linear ft (107 m)) of the East Dike Area as a relatively hard waste mass (see Figure 1). In a previous report by HLA [HLA, 1991c], the waste in the middle to northern portions of the East Dike Area was described as "*black cindery waste: dry, soft; some municipal waste; soft, with gravel size rubbery waste*". However, based on observations made during the supplemental site investigation, the waste previously described as "cindery" appears to be rubber crumb in a hard and friable state. The southern portion of the investigated area (210 linear ft (64 m)) contains rubber crumb that is not as hard as the middle portion of the East Dike Area (see Figure 1).

4.1.2 Conclusions

Based on the results and observations of the supplemental East Dike Area investigation: (i) in-situ solidification of the northern portion of the East Dike Area to the specified physical and hydraulic performance criteria is technically infeasible; (ii) successful in-situ solidification of the rubber crumb and rubbery wastes disposed in the East Dike Area may be infeasible due to the high organic content of the waste (up to 89.3 percent); and (iii) successful in-situ solidification of a relatively hard waste mass of rubber crumb is likely to be more difficult and costly than solidification of a "cindery material", since the "cindery" description implies a granular material.

Information regarding the technical infeasibility of solidifying co-disposed wastes and wastes containing rubber crumb was presented in the TM-NDA and will not be repeated in this document. In addition, according to the ROD for the Bailey Superfund Site, the functions of solidification are to "*reduce the mobility of the wastes and provide strength to support the cap.*" Based on the results presented in this report, the wastes in the East Dike Area have adequate strength to support a final cover system and solidification for this purpose is not needed.

4.2 <u>Pit B</u>

4.2.1 Summary of Results

As shown on Tables 4 and 5, one sample and its duplicate that were collected from the eastern portion of Pit B (G-PB-W-1 and G-PB-W-1 DUP) slightly exceeded the TCLP regulatory level for benzene by 1.3 and 2.5 parts per million, respectively. A statistical evaluation of the analytical data for the Pit B waste samples collected during the supplemental site investigation demonstrates that benzene is present at hazardous levels in the eastern portion of Pit B when compared to TCLP regulatory levels, as prescribed in 40 CFR §261.24. The statistical analysis was performed using methods presented in "*Chapter Nine -Sampling Plan, Test Methods for Evaluating Solid Waste [EPA/SW-846]*" [USEPA, 1986]. In addition, benzene in sample G-PB-W-1 was detected at a concentration greater than the universal treatment standard (UTS) for benzene as set in 40 CFR §268.48.

It should be noted that several constituent concentrations exceeded UTSs but not TCLP regulatory levels. Since UTSs are only applicable when constituents are present at concentrations greater than hazardous levels when compared to TCLP regulatory levels, the UTS do not apply to these constituent concentrations because the TCLP regulatory levels were not exceeded.

4.2.2 Conclusions

Based on the results of the supplemental site investigation, GeoSyntec recommends that Pit B be considered an isolated "hot spot", consistent with the definition presented in "Presumptive Remedy for CERCLA Municipal Landfill Sites." However, additional investigations are necessary to accurately evaluate the lateral and vertical limits of Pit B and to estimate the volume of waste and affected sediments that exhibit hazardous characteristics.

5. REFERENCES

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Woodward-Clyde Consultants, *Bailey Dump Superfund Site, Remedial Investigation, Orange County, Texas*, 29 July 1987.

TABLES

TABLE 1

SUMMARY OF COLLECTED SAMPLES
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Test Pit	Sample Identification	Sample Type	Sample Depth (ft)
G-TP14	G-TP14-W-1 G-TP14-W-2 G-TP14-S-1	Waste Waste Soil	3.0 to 4.0 5.0 to 6.0 7.0 to 8.0
G-TP15	G-TP15-W-1 G-TP15-W-2 G-TP15-S-1	Waste Waste Soil	5.0 to 6.0 7.0 to 8.0 9.0 to 10.0
G-TP16	G-TP16-W-1 G-TP16-W-2	Waste Waste	5.0 7.0 to 8.0
G-TP17	G-TP17-W-1	Waste	4.0 to 5.0
G-TP18	G-TP18-W-1	Waste	1.0
G-TP19	G-TP19-W-1	Waste	6.0

Note: Waste samples were not collected from test pit G-TP20 due to the similarity of the waste observed in test pits G-TP17 through G-TP20.

TABLE 2

SUMMARY OF PERFORMED ANALYSES
PIT B INVESTIGATION
BAILEY SUPERFUND SITE

Sample Identification	Total Metals ((Method 6010)	TCLP Metals (Method 6010)	Total SVOCs (Method 8270)	Total SVOCs (Method 8270)	TCLP VOCs (Method 8260)	TCLP VOCs (Method 8260)	Reactive Cyanide (Method 7.3.3 2)	Reactive Sulfide (Method 7.3.4.1)	Waste Profile Corrosivity (Method 150.1)	Waste Profile Ignitability (Method 1010)
G-PB-W-1	X	X	X	X	X	X	X	X	X	X
G-PB-W-1 DUP		X		X		X				
G-PB-W-2	X	X	X	X	X	X	X	X	X	X
G-PB-W-3		X		X		X	X	X	X	X
G-PB-W-4	X	X	X	X	X	X	X	X	X	X

TABLE 3

WASTE CHARACTERIZATION RESULTS
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Sample No		G-TP14-W-1		G-TP14-W-2		G-TP15-W-1		G-TP15-W-2		G-TP16-W-1		G-TP16-W-2		G-TP17-W-1		G-TP18-W-1		G-TP19-W-1		TOTALS	PERCENT OF TOTAL
Sample Depth (feet)		3.0 to 4.0		5.0 to 6.0		5.0 to 6.0		7.0 to 8.0		5.0		7.0 to 8.0		4.0 to 5.0		1.0		6.0			
Total Weight (lbs)		19.25		21.30		6.00		15.00		4.50		6.50		3.50		4.50		4.42		84.97	
Total Volume (gal)		3.00		2.00		0.78		1.04		0.45		0.55		0.53		0.58		0.66		9.59	
Glass > 1"	Weight (lbs)			1.00				1.00												2.00	
1/2" < Glass < 1"	Weight (lbs)			1.50				0.75												2.25	
1/4" < Glass < 1/2"	Weight (lbs)			1.00				0.33												1.33	
Glass < 1/4"	Weight (lbs)			0.00				0.00												0.00	
Total Glass	Weight (lbs)	0.00	0%	3.50	16%	0.00	0%	2.08	14%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	5.58	7%
	Volume (gal)	0.00	0%	0.33	17%	0.00	0%	0.16	15%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.49	5%
Metal > 1"	Weight (lbs)			0.80				0.75												1.55	
1/2" < Metal < 1"	Weight (lbs)			0.00				0.00												0.00	
1/4" < Metal < 1/2"	Weight (lbs)			0.00				0.00												0.00	
Metal < 1/4"	Weight (lbs)			0.00				0.00												0.00	
Total Metal	Weight (lbs)	0.00	0%	0.80	4%	0.00	0%	0.75	5%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	1.55	2%
	Volume (gal)	0.00	0%	0.20	10%	0.00	0%	0.02	2%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.22	2%
Decomposed MSW/Soil > 1"	Weight (lbs)			6.00				2.50												8.50	
1/2" < Decomposed MSW/Soil < 1"	Weight (lbs)			4.00				1.50												5.50	
1/4" < Decomposed MSW/Soil < 1/2"	Weight (lbs)			2.00				0.67												2.67	
Decomposed MSW/Soil < 1/4"	Weight (lbs)			5.00				5.00												10.00	
Total Decomposed MSW/Soil	Weight (lbs)	0.00	0%	17.00	80%	0.00	0%	9.67	64%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	26.67	31%
	Volume (gal)	0.00	0%	1.47	74%	0.00	0%	0.74	71%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	2.21	23%
Rubber Crumb > 1"	Weight (lbs)	16.00				2.00								0.00		0.00		0.00		18.00	
1/2" < Rubber Crumb < 1"	Weight (lbs)	1.00				1.50								0.00		0.00		0.25		2.75	
1/4" < Rubber Crumb < 1/2"	Weight (lbs)	0.75				0.50								0.10		0.00		0.17		1.52	
Rubber Crumb < 1/4"	Weight (lbs)	1.50				2.00								3.40		3.50		4.00		14.40	
Total Rubber Crumb	Weight (lbs)	19.25	100%	0.00	0%	6.00	100%	0.00	0%	0.00	0%	0.00	0%	3.50	100%	3.50	78%	4.42	100%	36.67	43%
	Volume (gal)	3.00	100%	0.00	0%	0.78	100%	0.00	0%	0.00	0%	0.00	0%	0.53	100%	0.40	69%	0.66	100%	5.37	56%
Thick Rubbery Sludge > 1"	Weight (lbs)									0.50		0.00								0.50	
1/2" < Thick Rubbery Sludge < 1"	Weight (lbs)									0.00		0.00								0.00	
1/4" < Thick Rubbery Sludge < 1/2"	Weight (lbs)									0.00		0.30								0.30	
Thick Rubbery Sludge < 1/4"	Weight (lbs)									4.00		5.70								9.70	
Total Thick Rubbery Sludge	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	4.50	100%	6.00	92%	0.00	0%	0.00	0%	0.00	0%	10.50	12%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.45	100%	0.53	96%	0.00	0%	0.00	0%	0.00	0%	0.98	10%
Wood > 1"	Weight (lbs)											0.50								0.50	
1/2" < Wood < 1"	Weight (lbs)											0.00								0.00	
1/4" < Wood < 1/2"	Weight (lbs)											0.00								0.00	
Wood < 1/4"	Weight (lbs)											0.00								0.00	
Total Wood	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.50	8%	0.00	0%	0.00	0%	0.00	0%	0.50	1%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.02	4%	0.00	0%	0.00	0%	0.00	0%	0.02	0%
Brick	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	2.50	17%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	2.50	3%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.12	12%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.12	1%
Stones	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.50	11%	0.00	0%	0.50	1%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.09	16%	0.00	0%	0.09	1%
Sea Shells	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.50	11%	0.00	0%	0.50	1%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.09	16%	0.00	0%	0.09	1%
Notes.		one piece of rubber material weighed 13 lbs						decanted 0.18 gal of water from sample		sample included one piece of rubber crumb (1 in. by 3 in.)		sample included one piece of rubber crumb (3/4 in. by 2 in.)				sample included one piece of wood (1 in. by 2 in.)					

TABLE 4
ANALYTICAL RESULTS
PIT B INVESTIGATION
BAILEY SUPERFUND SITE

Parameter	Units	G-PB-W-1	G-PB-W-2	G-PB-W-3	G-PB-W-4	G-PB-W-1-DUP
VOLATILE ORGANIC COMPOUNDS						
1,1-DICHLOROETHANE	mg/kg	ND	ND	NA	16	NA
2-BUTANONE (MEK)	mg/kg	ND	ND	NA	22	NA
BENZENE	mg/kg	35	4.7	NA	ND	NA
ETHYLBENZENE	mg/kg	86	15	NA	48	NA
STYRENE	mg/kg	7.6	ND	NA	40	NA
TOLUENE	mg/kg	23	ND	NA	19	NA
XYLENES (TOTAL)	mg/kg	52	7 4	NA	29	NA
TCLP - VOLATILE ORGANIC COMPOUNDS						
TCLP-1,2-DICHLOROETHANE	mg/l	0.1	ND	0.1	0.42	0.5
TCLP-2-BUTANONE (MEK)	mg/l	ND	ND	ND	ND	0.022
TCLP-BENZENE	mg/l	1 8	0.07	0.15	0.44	3.0
TCLP-TETRACHLOROETHENE	mg/l	ND	ND	ND	ND	0.018
TCLP-TRICHLOROETHENE	mg/l	0.02	ND	ND	0.043	0.01
SEMIVOLATILE ORGANIC COMPOUNDS						
2-METHYLNAPHTHALENE	mg/kg	368	ND	NA	150	NA
ACENAPHTHENE	mg/kg	79.4	ND	NA	ND	NA
ACENAPHTHYLENE	mg/kg	71.2	ND	NA	ND	NA
ANTHRACENE	mg/kg	150	ND	NA	161	NA
FLUORENE	mg/kg	101	ND	NA	ND	NA
NAPHTHALENE	mg/kg	507	ND	NA	193	NA
PHENANTHRENE	mg/kg	238	ND	NA	136	NA
PYRENE	mg/kg	67.8	ND	NA	ND	NA
TCLP-SEMIVOLATILE ORGANIC COMPOUNDS						
TCLP-CRESOL	mg/l	0.14	0.176	0 2	ND	1.11
METALS						
ALUMINUM	mg/kg	8900	7200	NA	3600	NA
ARSENIC	mg/kg	9.0	ND	NA	ND	NA
BARIUM	mg/kg	940	380	NA	180	NA
BERYLLIUM	mg/kg	0.1	ND	NA	0.4	NA
CADMIUM	mg/kg	3.4	2.0	NA	0.5	NA
CALCIUM	mg/kg	11000	19000	NA	1400	NA
CHROMIUM	mg/kg	190	160	NA	27	NA
COBALT	mg/kg	8.2	6.1	NA	8.2	NA
COPPER	mg/kg	105	130	NA	33	NA
IRON	mg/kg	18000	33000	NA	10200	NA
LEAD	mg/kg	220	NA	NA	66	NA
MAGNESIUM	mg/kg	1900	3000	NA	1200	NA
MANGANESE	mg/kg	170	270	NA	210	NA
NICKEL	mg/kg	21	22	NA	18	NA
POTASSIUM	mg/kg	1700	1700	NA	560	NA
SILVER	mg/kg	1.7	1.1	NA	ND	NA
SODIUM	mg/kg	2800	5400	NA	1000	NA
VANADIUM	mg/kg	18	20	NA	8.0	NA
ZINC	mg/kg	900	600	NA	170	NA
TCLP-METALS						
TCLP-ARSENIC	mg/l	0.03	0.04	ND	ND	ND
TCLP-BARIUM	mg/l	3.1	2.9	1.1	1.8	1.6
TCLP-CADMIUM	mg/l	ND	0.002	ND	ND	0.001
TCLP-CHROMIUM	mg/l	0.028	0.08	ND	0.03	0.018
TCLP-LEAD	mg/l	ND	ND	ND	0.019	ND
MISCELLANEOUS						
pH	Standard Units	7.3	7.0	6.9	5.4	NA
REACTIVE SULFIDE (Method 7 3.4 1)	mg/kg	360	380	300	740	NA
WASTE PROFILE IGNITABILITY	Deg F	> 210	> 210	> 210	> 210	NA

Legend:
ND - Parameter not detected at concentration equal to or greater than minimum laboratory detection limit.
NA - Parameter not analyzed for.

Note:
Table only includes those parameters that were deteced in at least one sample.

TABLE 5
COMPARISON OF ANALYTICAL RESULTS AND APPLICABLE REGULATORY LEVELS
PIT B INVESTIGATION
BAILEY SUPERFUND SITE

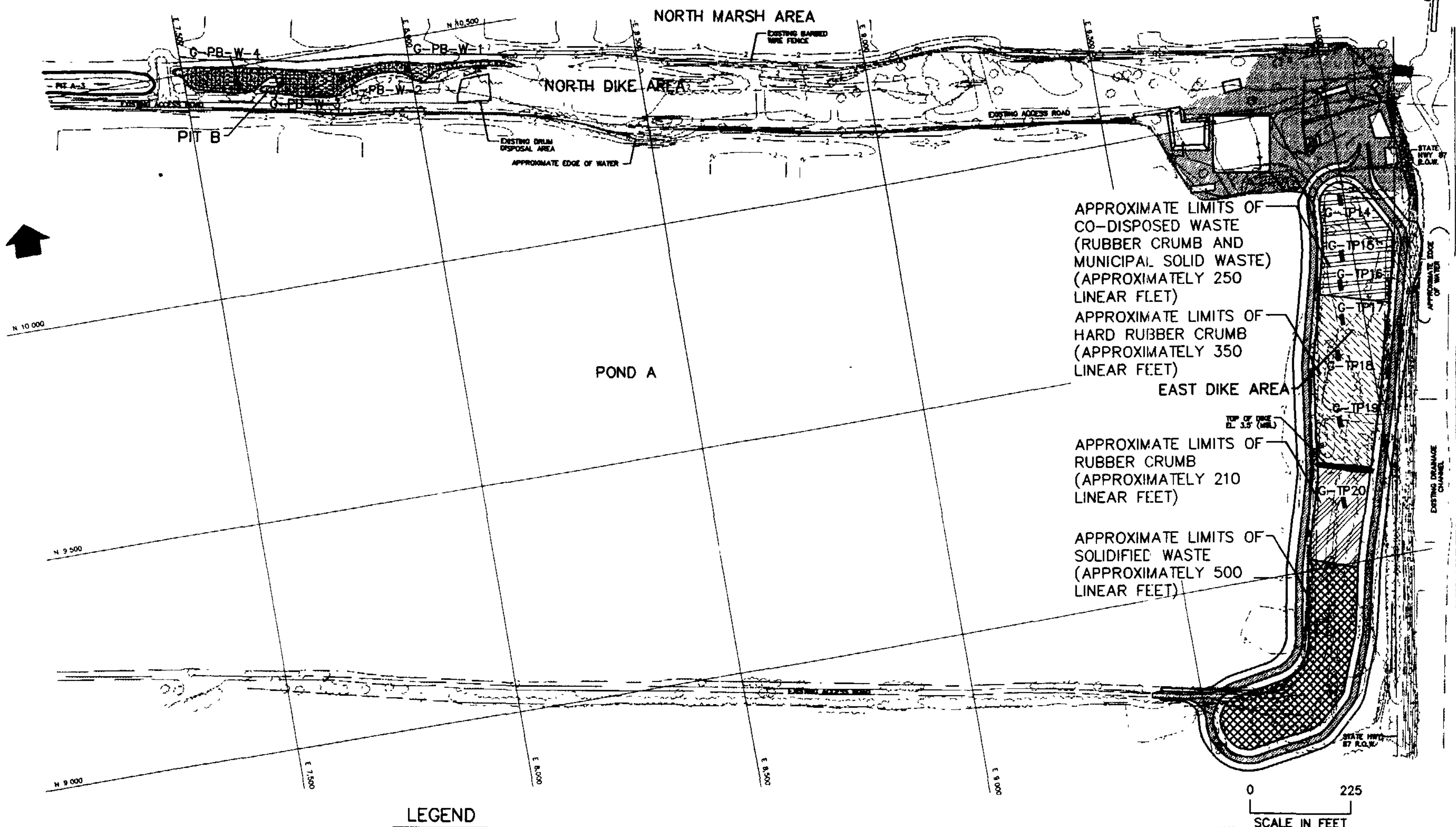
Parameter	Units	Applicable Regulatory Value	Average Value (mg/kg)	Maximum Value (mg/kg)	Minimum Value (mg/kg)	Total Samples
VOLATILE ORGANIC COMPOUNDS (2)						
1,1-DICHLOROETHANE	mg/kg	6.0	5.3	16	ND	3
2-BUTANONE (MEK)	mg/kg	NA	7.3	22	ND	3
BENZENE	mg/kg	10	13.2	35	ND	3
ETHYLBENZENE	mg/kg	10	49.7	86	15	3
STYRENE	mg/kg	NA	15.9	40	ND	3
TOLUENE	mg/kg	10	14.0	23	ND	2
XYLENES (TOTAL)	mg/kg	30	29.5	52	7.4	3
TCLP - VOLATILE ORGANIC COMPOUNDS (3)						
TCLP-1,2-DICHLOROETHANE	mg/l	0.5	0.224	0.5	ND	5
TCLP-2-BUTANONE (MEK)	mg/l	200	0.004	0.022	ND	5
TCLP-BENZENE	mg/l	0.5	1.092	3.0	0.07	5
TCLP-TETRACHLOROETHENE	mg/l	0.7	0.004	0.018	ND	5
TCLP-TRICHLOROETHENE	mg/l	0.5	0.015	0.043	ND	5
SEMIVOLATILE ORGANIC COMPOUNDS (2)						
2-METHYLNAPHTHALENE	mg/kg	NA	172.7	368	ND	3
ACENAPHTHENE	mg/kg	3.4	26.5	79.4	ND	3
ACENAPHTHYLENE	mg/kg	3.4	23.7	71.2	ND	3
ANTHRACENE	mg/kg	3.4	103.7	161	ND	3
FLUORENE	mg/kg	3.4	33.7	101	ND	3
NAPHTHALENE	mg/kg	5.6	233.3	507	ND	3
PHENANTHRENE	mg/kg	5.6	124.7	238	ND	3
PYRENE	mg/kg	NA	22.6	67.8	ND	3
TCLP-SEMIVOLATILE ORGANIC COMPOUNDS (3)						
TCLP-CRESOL	mg/l	200	0.325	1.11	ND	5
METALS						
ALUMINUM	mg/kg	NA	6566.7	8900	3600	3
ARSENIC	mg/kg	NA	3.0	9.0	ND	3
BARIUM	mg/kg	NA	500.0	940	180	3
BERYLLIUM	mg/kg	NA	0.2	0.4	ND	3
CADMIUM	mg/kg	NA	2.0	3.4	0.5	3
CALCIUM	mg/kg	NA	10466.7	19000	1400	3
CHROMIUM	mg/kg	NA	125.7	190	27	3
COBALT	mg/kg	NA	7.5	8.2	6.1	3
COPPER	mg/kg	NA	89.3	130	33	3
IRON	mg/kg	NA	20400.0	33000	10200	3
LEAD	mg/kg	NA	143.0	220	66	2
MAGNESIUM	mg/kg	NA	2033.3	3000	1200	3
MANGANESE	mg/kg	NA	216.7	270	170	3
NICKEL	mg/kg	NA	20.3	22	18	3
POTASSIUM	mg/kg	NA	1320.0	1700	560	3
SILVER	mg/kg	NA	0.9	1.7	ND	3
SODIUM	mg/kg	NA	3066.7	5400	1000	3
VANADIUM	mg/kg	NA	15.3	20	8.0	3
ZINC	mg/kg	NA	556.7	900	170	3
TCLP-METALS (3)						
TCLP-ARSENIC		5.0	0.014	0.04	ND	5
TCLP-BARIUM	mg/l	100	2.100	3.1	1.1	5
TCLP-CADMIUM	mg/l	1.0	0.001	0.002	ND	5
TCLP-CHROMIUM	mg/l	5.0	0.031	0.08	ND	5
TCLP-LEAD	mg/l	5.0	0.004	0.019	ND	5
MISCELLANEOUS						
pH	Standard Units	NA	6.65	7.3	5.4	4
REACTIVE SULFIDE (Method 7 3.4.1)	mg/kg	NA	445	740	300	4
WASTE PROFILE IGNITABILITY	Deg F	NA	>210	>210	>210	4

Legend:
NA - Not available or applicable.

Notes:
1. Table only includes those parameters that were detected in at least one sample.
2. These applicable regulatory values are universal treatment standards (UTSs) set in 40 CFR 268.48. These vaules are only applicable when constituents are present at concentrations greater than hazardous levels when compared to TCLP regulatory levels set in 40 CRF 261.24.
3. These applicable regulatory values are TCLP regulatory levels set in 40 CFR 261.24.

FIGURES

TEST PIT AND SAMPLE LOCATIONS
SUPPLEMENTAL SITE INVESTIGATION – EAST DIKE AREA AND PIT B
BAILEY SUPERFUND SITE



LEGEND

G-TP14	DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT
G-PB-W-1	DESIGNATION AND APPROXIMATE LOCATION OF WASTE SAMPLE LOCATION
	APPROXIMATE LIMITS OF PIT B
	APPROXIMATE LIMITS OF GRAVEL SURFACING
	APPROXIMATE LIMITS OF SOLIDIFIED WASTE
	APPROXIMATE LIMITS OF CO-DISPOSED WASTE
	APPROXIMATE LIMITS OF HARD RUBBER CRUMB
	APPROXIMATE LIMITS OF RUBBER CRUMB

NOTES:

BASE MAP PREPARED BY HARDING LAWSON ASSOCIATES, HOUSTON, TEXAS.

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ATLANTA, GA

PROJECT NO. GE3913-100	FIGURE NO. 1
DOCUMENT NO. GA951410	FILE NO. 3913F003

FIGURE 2
SAMPLE COMPOSITION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

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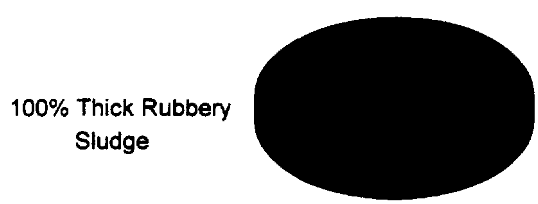
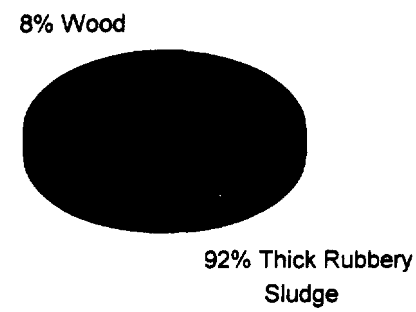
FIGURE 3
SAMPLE COMPOSITION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

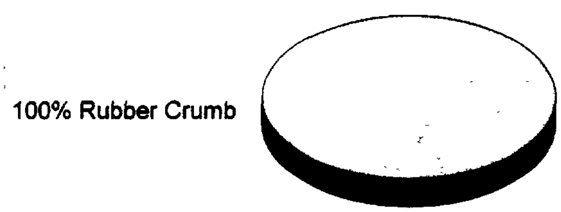
G-TP16-W-1



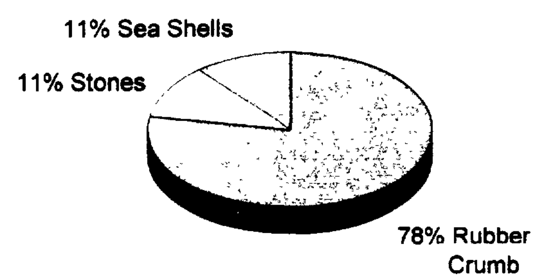
G-TP16-W-2



G-TP17-W-1



G-TP18-W-1



G-TP19-W-1

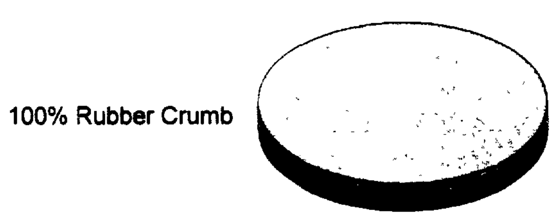


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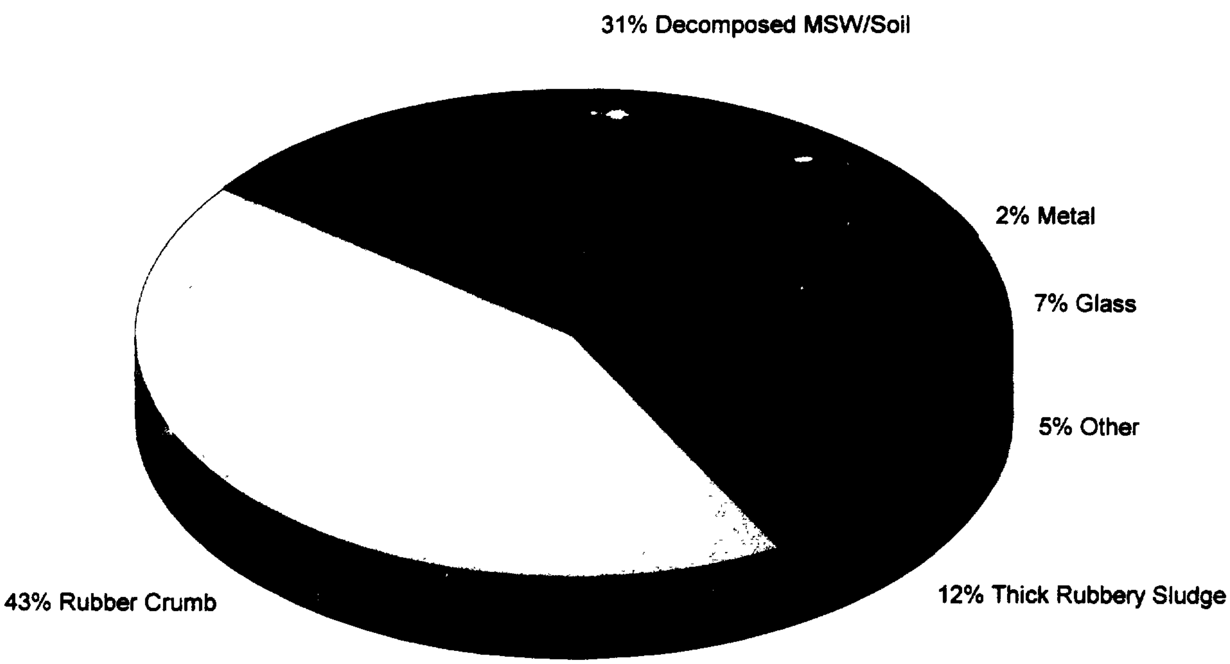
FIGURE 4
TOTAL WASTE COMPOSITION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE



COMPOSITION OF "OTHER"

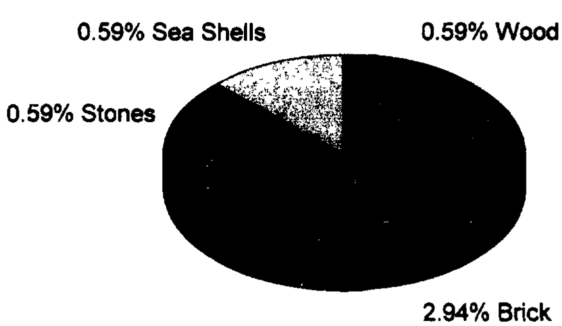


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FIGURE 5
RUBBER CRUMB GRADATION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

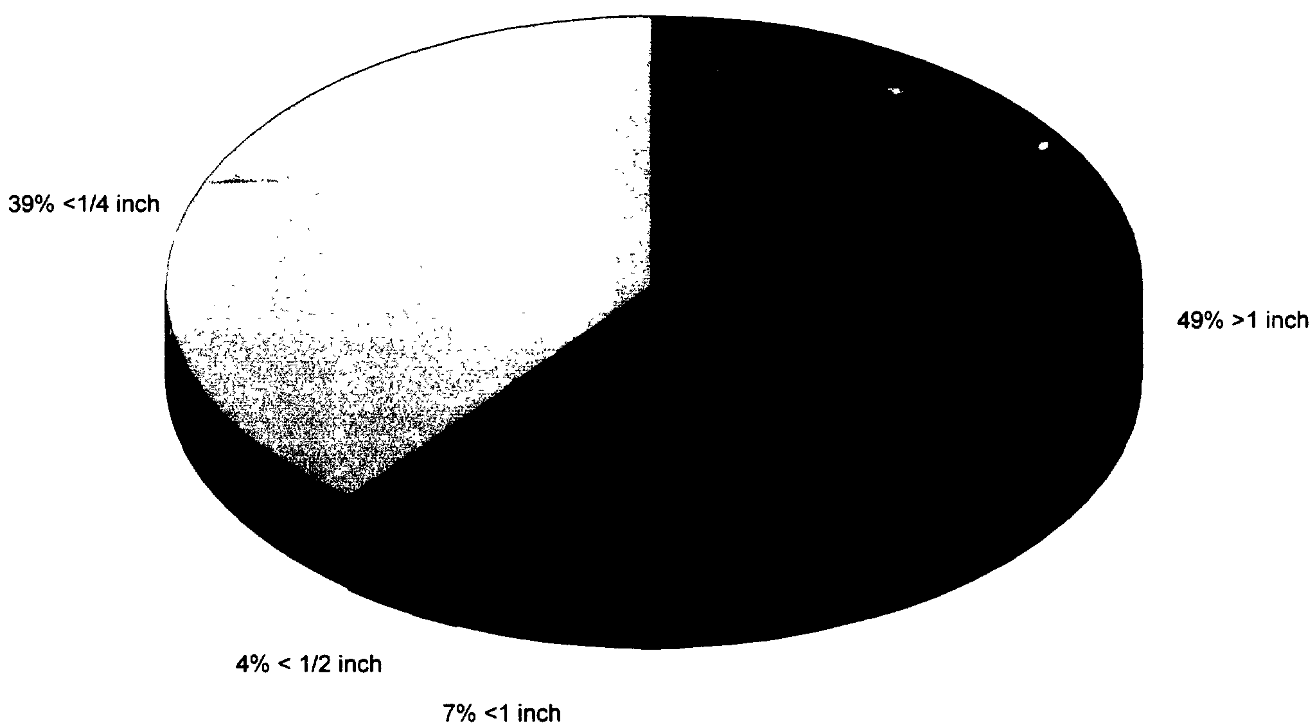

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FIGURE 6
DECOMPOSED MSW/SOIL GRADATION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE

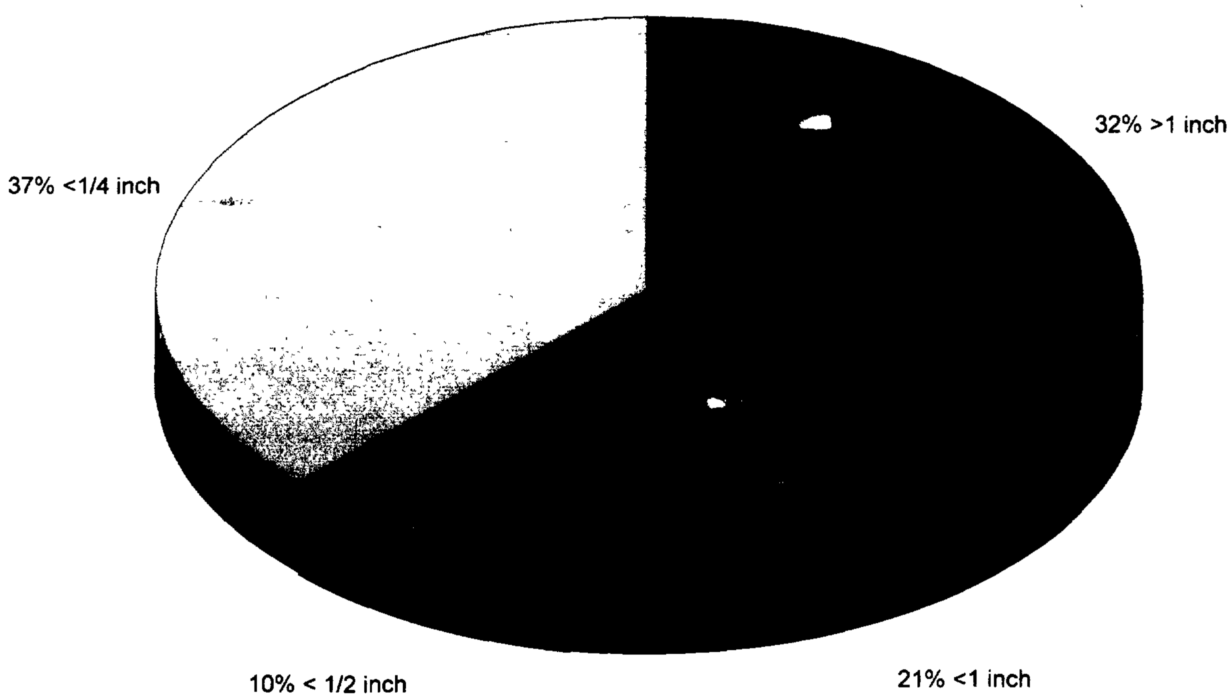

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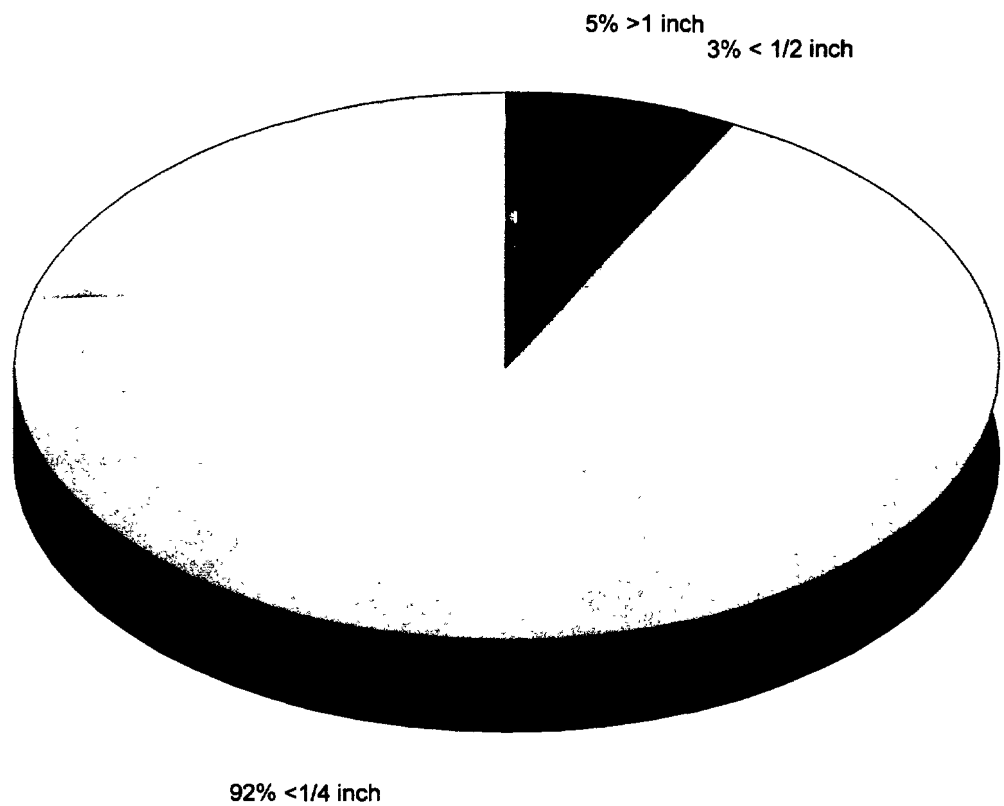
FIGURE 7
THICK RUBBERY SLUDGE GRADATION BY WEIGHT
EAST DIKE INVESTIGATION
BAILEY SUPERFUND SITE



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APPENDIX A

TEST PIT OBSERVATIONS AND PHOTOGRAPHS

EAST DIKE INVESTIGATION

Test Pit:	**G-TP14**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	6.5
Depth to Ground Water (feet):	6.0
Description of Soil beneath Waste:	Gray silty SAND with clay
Bottom of Test Pit:	8.0
Samples (Depth (feet)):	G-TP-W-1 (3.0 to 4.0) G-TP-W-2 (5.0 to 6.0) G-TP-S-1 (7.0 to 8.0)

Excavated Waste Material Description:

The upper portion of the waste was a black mixture of rubber crumb and soil that extended from approximately 1.0 to 2.0 feet below the ground surface. From approximately 2.0 to 5.0 feet below the ground surface, the waste was black rubber crumb that was very hard and difficult to tear apart by hand. While excavating this waste, the backhoe would remove pieces or blocks of the waste by tearing it from what appeared to be a relatively solid mass of rubber crumb.

From approximately 5.0 to 6.5 feet below the ground surface, the waste was comprised of a municipal solid waste and soil mixture. This waste contained glass (10 to 20 percent), decomposed municipal solid waste and soil (60 to 80 percent), and metal (10 to 20 percent). The glass portion of the waste contained broken pieces of glass (90 percent) and unbroken glass bottles (10 percent).

Sample Description (G-TP14-W-1)

Black RUBBER CRUMB. There were several large pieces of elastic rubbery material. Sample headspace reading was 1,200 part per million (ppm) total volatile organic compounds (VOCs) when the top of the waste container was removed.

Sample Description (G-TP14-W-2)

Black DECOMPOSED MUNICIPAL SOLID WASTE AND SOIL MIXTURE. No rubber crumb was present. The sample contained some glass and metal. The portion of this waste sample that was less than 1/4 inch was soft and compressible.

Test Pit:	**G-TP15**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	1.0
Depth to Bottom of Waste (feet):	8.5
Depth to Ground Water (feet):	5.5
Description of Soil beneath Waste:	Gray silty SANΓ with clay
Bottom of Test Pit:	10.0
Samples (Depth (feet)):	G-TP15-W-1 (5.0 to 6.0) G-TP15-W-2 (7.0 to 8.0) G-TP15-S-1 (9.0 to 10.0)

Excavated Waste Material Description:

The upper portion of the waste was a black mixture of rubber crumb and soil that extended from approximately 1.0 to 2.0 feet below the ground surface. From approximately 2.0 to 6.0 feet below the ground surface, the waste contained black rubber crumb (80 percent) and wood (20 percent). A 15-foot long, 1-foot diameter telephone pole was excavated from the test pit from a depth of approximately 3.0 to 4.0 feet below the ground surface. Although this waste was relatively hard, it was not as hard as the material from G-TP14.

From approximately 6.0 to 8.5 feet below the ground surface, the waste was comprised of a municipal solid waste and soil mixture. This waste contained glass (10 to 15 percent), decomposed municipal solid waste and soil (40 to 50 percent), metal (5 to 10 percent), wood and tree limbs (25 percent), and bricks (10 percent). The glass portion of the waste contained broken pieces of glass (90 percent) and unbroken glass bottles (10 percent).

Sample Description (G-TP15-W-1)

Black oily RUBBER CRUMB. Sample was soft and compressible. Larger pieces could have easily been broken and pushed through smallest sieve size. No glass or other waste was present.

Sample Description (G-TP15-W-2)

Black DECOMPOSED MUNICIPAL SOLID WASTE AND SOIL MIXTURE. Approximately 0.18 gallons of liquid were decanted off the sample. The entire sample was wet. Some glass and metal was present along with half of a brick.

Test Pit:	**G-TP16**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	8.0
Depth to Ground Water (feet):	8.5
Description of Soil beneath Waste:	Gray silty SAND with clay
Bottom of Test Pit:	9.5
Samples (Depth (feet)):	G-TP16-W-1 (5.0) G-TP16-W-2 (7.0 to 8.0)

Excavated Waste Material Description:

The upper portion of the waste was black rubbery waste that extended from approximately 1.0 to 6.0 feet below the ground surface. A significant amount of wood material was observed at a depth of 1.5 feet.

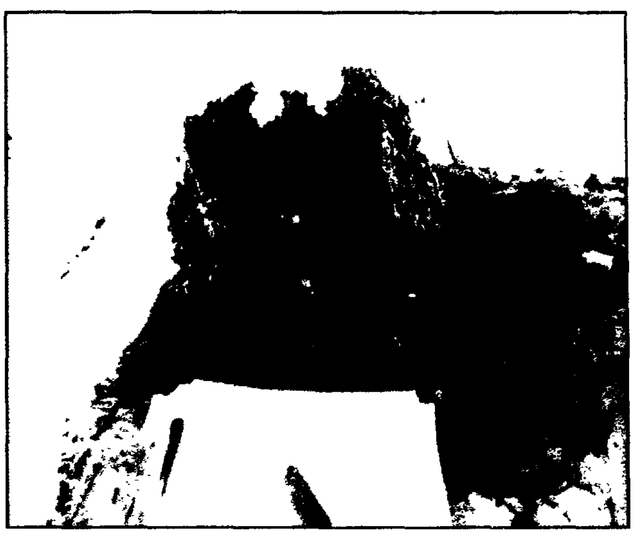
From approximately 6.0 to 8.0 feet below the ground surface, the waste was comprised of black rubbery waste and a municipal solid waste and soil mixture. The municipal solid waste contained broken glass (10 to 20 percent), decomposed municipal solid waste and soil (70 to 80 percent), and wood and tree limbs (10 percent).

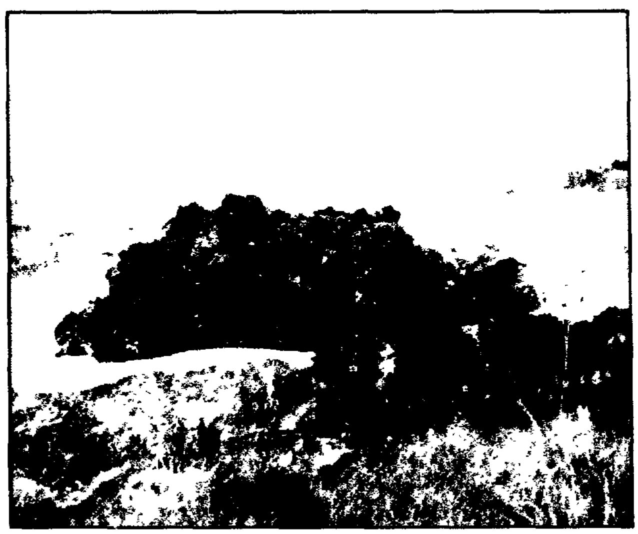
Sample Description (G-TP16-W-1)

Black THICK RUBBERY SLUDGE. The sample had the consistency of creamy peanut butter. Only one small piece of rubbery crumb (1 inch by 3 inches) was present.

Sample Description (G-TP16-W-2)

Black THICK RUBBERY SLUDGE. The sample had the consistency of creamy peanut butter. Liquid residue from the sample dried to a dull finish. A small piece of wood (1 inch by 6 inches) and a small piece of rubber crumb (3/4 inch by 2 inches) were present.





Test Pit:	**G-TP17**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	8.5
Depth to Ground Water (feet):	4.5 to 5.0
Description of Soil beneath Waste:	Gray clayey SILT
Bottom of Test Pit:	10.0
Samples (Depth (feet)):	G-TP17-W-1 (4.0 to 5.0)

Excavated Waste Material Description:

The upper portion of the waste was a black mixture of rubber crumb and soil that extended from approximately 1.0 to 3.0 feet below the ground surface. From approximately 3.0 to 8.5 feet below the ground surface, the waste was black rubber crumb that was very hard and difficult to tear apart by hand. While excavating this waste, the backhoe would remove pieces or blocks of the waste by tearing it from what appeared to be a relatively solid mass of rubber crumb.

Sample Description (G-TP17-W-1)

Black RUBBER CRUMB. The sample was less elastic than rubber crumb samples from test pits G-TP14 and G-TP15. The sample did not have an oily sheen. Many small pieces of rubber crumb were present but they were not very elastic and would crumble when compressed.

Test Pit:	**G-TP18**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	4.0
Depth to Ground Water (feet):	Not Encountered
Description of Soil beneath Waste:	Gray clayey SILT
Bottom of Test Pit:	6.5
Samples (Depth (feet)):	G-TP18-W-1 (1.0)

Excavated Waste Material Description:

The waste was black rubber crumb that extended from approximately 1.0 to 4.0 feet below the ground surface. This waste was very hard and difficult to tear apart by hand. While excavating this waste, the backhoe would remove pieces or blocks of the waste by tearing it from what appeared to be a relatively solid mass of rubber crumb.

Sample Description (G-TP18-W-1)

Black RUBBER CRUMB. The sample did not have an oily sheen. The sample was fairly granular and friable. A small piece of wood (1 inch by 2 inches), small rocks (less than 1 inch diameter), and seashells (less than 2 inches in length) were present

Test Pit:	**G-TP19**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	8.0
Depth to Ground Water (feet):	Not Encountered
Description of Soil beneath Waste:	Gray clayey SILT
Bottom of Test Pit:	10.0
Samples (Depth (feet)):	G-TP19-W-1 (6.0)

Excavated Waste Material Description:

The waste was black rubber crumb that extended from approximately 1.0 to 8.0 feet below the ground surface. This waste was more elastic than the waste from G-TP18. While excavating this waste, the backhoe would remove pieces or blocks of the waste by tearing it from what appeared to be a relatively solid mass of rubber crumb.

Sample Description (G-TP19-W-1)

Black RUBBER CRUMB. The sample is somewhat spongy and elastic. The sample was not very sticky or friable.

Test Pit:	**G-TP20**
Date Excavated:	13 November 1995
Overburden Thickness (feet):	0.0
Depth to Bottom of Waste (feet):	6.0
Depth to Ground Water (feet):	Not Encountered
Description of Soil beneath Waste:	Gray clayey SILT
Bottom of Test Pit:	7.0
Samples (Depth (feet)):	None

Excavated Waste Material Description:

The waste from this test pit extended from the ground surface to a depth of approximately 6.0 feet. This waste was a black elastic rubber crumb material. A relatively high instantaneous reading of 120 ppm total VOCs was measured in the breathing zone during the excavation activities.

NOMENCLATURE

Major sample components:	upper case letters used to describe predominant component (e.g., "DECOMPOSED MUNICIPAL SOLID WASTE"). When two or more predominant components could not be separated by hand or by sieving, the word "MIXTURE" is used (e.g. DECOMPOSED MUNICIPAL SOLID WASTE AND SOIL MIXTURE).
Secondary sample component:	adjective used if visually significant (e.g. "silty", "oily").
Third sample component:	the word "with" is used where component is less than secondary component, but still significant.
Fourth sample component:	the word "some" is used where component is less than third component, but is still significant.

DEFINITIONS

DECOMPOSED MUNICIPAL SOLID WASTE - This description is used for decomposed or partially decomposed material that probably originated as household waste, commercial solid waste, non-hazardous sludge, small quantity generator waste, or industrial solid waste. Typically the material categorized as municipal solid waste was a black detritus with occasional identifiable components (e.g. glass, wire, wood and other debris). It typically had a high moisture or liquid content, and an organic smell. In several cases, the material was classified as DECOMPOSED MUNICIPAL SOLID WASTE AND SOIL MIXTURE. This description was used when the material appeared to have a soil content (either granular or silty clay), but the soil fraction could not be physically separated by hand picking or by sieving. It is likely that the soil was originally added to the waste as a daily or intermediate cover. As the waste decomposed and was tracked over by heavy equipment, it likely became mixed with the waste.

RUBBER CRUMB - This description is used for small pieces (generally less than 1 inch in diameter) of black material that generally exhibited a high elasticity (i.e. when stretched or compressed would tend to rebound). The material appeared to have a high carbon-black content, and was observed in several states ranging from a tough fairly stiff rubber, to a semi-elastic material that was very tarry and sticky (almost caramel consistency).

THICK RUBBERY SLUDGE - This term was used to describe black waste material that was a creamy, semi-elastic, viscous substance that had a consistency of creamy peanut butter. The material appeared to have a high organic content.

APPENDIX B

LABORATORY TESTING RESULTS

EAST DIKE INVESTIGATION

GEOSYNTEC CONSULTANTS

Geomechanics & Environmental Laboratory
5775 Peachtree Dunwoody Road, Suite 10D
Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300

28 December 1995

Mr. R. Neil Davies, P.E.
GeoSyntec Consultants
1100 Lake Hearn Drive, Suite 200
Atlanta, Georgia 30342

Subject: Final Report - Laboratory Test Results
Supplemental Site Investigation, East Dike Area
Bailey Superfund Site
Bridge City, Texas

Dear Mr. Davies:

GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia, is pleased to present the attached final test results (Tables 1 and 2 and Figure 1) for the above referenced project. A blank shown on any of the tables or the figure indicates that the test was not performed, the parameter is not applicable, or that the test resulted in insufficient data to report the designated parameter. Attachment A presents the general information pertinent to the testing program, and the policy of GeoSyntec regarding the limitations and use of the test results.

The Geomechanics and Environmental Laboratory appreciates the opportunity to provide testing services for this project. Should you have any questions regarding the attached test results or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Jens B. Stoltz
FOR
Brian D. Jacobson, E.I.T.
Assistant Program Manager
Environmental Testing

Nader S. Rad

Nader S. Rad, Ph.D., P.E.
Laboratory Director

Attachment

GE3913/GEL95360

Corporate Office:
621 N.W. 53rd Street • Suite 650
Boca Raton, Florida 33487 • USA
Tel. (407) 995-0900 • Fax (407) 995-0925

Regional Offices:
Atlanta, GA • Austin, TX • Boca Raton, FL • Chicago, IL • Columbia, MD
Huntington Beach, CA • San Antonio, TX • Walnut Creek, CA
Brussels, Belgium • Nancy, France

Laboratories:
Atlanta, GA
Boca Raton, FL
Huntington Beach, CA

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS
WASTE

BAILEY SITE SETTLORS COMMITTEE (BSSC)
SUPPLEMENTAL SITE INVESTIGATION, EAST DIKE AREA

Site Sample ID	Lab Sample No.	Moisture Content[1] ASTM D 2216 (%)	Percent Passing No. 4 Sieve (%)	Loss on Ignition[2][3][4] ASTM D 2947 (%)
G-TP14-W-1	E95K26	60.5	64.1	82.1
G-TP14-W-2	E95K16	27.2	21.5	3.2
G-TP15-W-1	E95K17	54.9	38.1	16.5
G-TP16-W-1	E95K28	54.7	75.0	24.6
G-TP16-W-2	E95K18	56.2	17.8	17.5
G-TP17-W-1	E95K29	85.7	51.1	89.3
G-TP19-W-1	E95K31	111.0	74.4	83.9

Notes:

1. Values were determined using a representative specimen of the bulk sample.
2. Testing was performed on the portion of the oven-dried material which passed through a standard No. 4 sieve.
3. Oven temperature was 824°F (440°C).
4. The Loss on Ignition (LOI) test is a measure of the weight of all organic material in the specimen. The Total Organic Carbon (TOC) test is a measure of the weight of only the organic carbon in the specimen.

TABLE 2

SUMMARY OF LABORATORY TEST RESULTS
SOIL

BAILEY SITE SETTLORS COMMITTEE (BSSC)
SUPPLEMENTAL SITE INVESTIGATION, EAST DIKE AREA

Client Sample ID	Lab Sample No.	Sample Depth (ft)	Grain Size: Percent Passing #200 Sieve ASTM D 1140 (%)	Grain Size: ASTM D 422 Sieve Figure No.	Grain Size: ASTM D 422 Hydrom. Figure No.	Atterberg Limits ASTM D 4318: LL (%)	Atterberg Limits ASTM D 4318: PL (%)	Atterberg Limits ASTM D 4318: PI (-)	Soil Classification ASTM D 2487	Compaction ASTM D 698: Max. Dry Unit Weight (pcf)	Compaction ASTM D 698: Optimum Moisture Content (%)	Compaction ASTM D 698: Figure No.	Hydraulic Conductivity ASTM D 5084: Test Specimen Initial Conditions Dry Unit Weight (pcf)	Hydraulic Conductivity ASTM D 5084: Test Specimen Initial Conditions Moisture Content (%)	Hydraulic Conductivity ASTM D 5084: Test Specimen Initial Conditions Consolidation Pressure (psi)	Hydraulic Conductivity ASTM D 5084: Hydraulic Conductivity (cm/s)
G-TP14-S-1	E95K22		96.0			50	16	34	CL - Lean Clay				63.0	37.5	5	6 5E-9
G-TP15-S-1	E95K21		95.4			67	19	48	CH - Fat Clay				66 7	55 1	5	1.8E-8

ATTACHMENT A

Sample Identification, Handling, Storage and Disposal

Laboratory Test Standards

Application of Test Results

SAMPLE IDENTIFICATION, HANDLING, STORAGE AND DISPOSAL

Test materials were sent to GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia by the client or its representative(s). Samples delivered to the laboratory were identified by client sample identification (ID) numbers which had been assigned by representative(s) of the client. Upon being received at the laboratory, each sample was assigned a laboratory sample number to facilitate tracking and documentation

Based on the information provided to GeoSyntec by the client or its representative(s) and, when applicable, procedural guidelines recommended by an industrial hygiene consultant, the following Occupational Safety and Health Administration (OSHA) level of personal protection was adopted for handling and testing of the test materials:

[ ] test materials were not contaminated, no special protection measures were taken;
[X] level D
[ ] level C
[ ] level B

In accordance with the health and safety guidelines of GeoSyntec, contaminated materials are stored in a designated containment area in the laboratory. Non-contaminated materials are stored in a general storage area in the laboratory.

GeoSyntec Geomechanics and Environmental Laboratory will continue storing the test materials for a period of 30 days from the date of this report or a year from the time that the samples were received, which ever is shorter Thereafter: (i) contaminated materials will be returned to the client or its designated representative(s), and (ii) the materials which are not contaminated will be discarded unless long-term storage arrangements are specifically made with GeoSyntec Geomechanics and Environmental Laboratory.

LABORATORY TEST STANDARDS

At the request of the client, the laboratory testing program was performed utilizing the guidelines provided in the following test standards:

[X] **moisture content** - American Society for Testing and Materials (ASTM) D 2216 "*Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures*";

[ ] **moisture content** - ASTM D 4643 "*Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Method*";

[X] **particle-size analysis** - ASTM 422, "*Standard Method for Particle-Size Analysis of Soils*",

[X] **percent passing No. 200 sieve** - ASTM D 1140, "*Standard Test Method for Amount of Material in Soil Finer Than No 200 (75 microns) sieve*";

[X] **Atterberg limits** - ASTM D 4318, "*Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*";

[X] **soil classification** - ASTM D 2487, "*Standard Test Method for Classification of Soils for Engineering Purposes*",

[ ] **soil pH** - ASTM D 4972, "*Standard Test Method for pH of Soils*";

[ ] **soil pH** - United States Environmental Protection Agency (USEPA) SW-846 Method 9045, Revision 1, 1987, Standard Test Method for Measurement of "*Soil pH*";

[ ] **specific gravity** - ASTM D 854, "*Standard Test Method for Specific Gravity of Soils*";

[ ] **carbonate content** - ASTM D 3042, "*Standard Method for Insoluble Residue in Carbonate Aggregates*";

[ ] **soundness** - ASTM C 88, *"Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate"*,

[X] **loss-on-ignition (LOI)** - ASTM D 2974, *"Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"*,

[ ] **standard Proctor compaction** - ASTM D 698, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2 49-kg) Rammer and 12-in. (305-mm) Drop"*,

[ ] **modified Proctor compaction** - ASTM D 1557, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop"*,

[ ] **maximum relative density** - ASTM D 4253, *"Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table"*;

[ ] **minimum relative density** - ASTM D 4254, *"Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"*,

[ ] **mass per unit area** - ASTM D 3776, *"Standard Test Method for Mass Per Unit Area (weight) of Woven Fabric"*;

[ ] **thickness measurement** - ASTM D 1777, *"Standard Test Method for Measuring Thickness of Textile Materials"*,

[ ] **free swell** - United States Pharmacopeia National Formulary (USP-NF) XVII, *"Swell Index of Clay"*;

[ ] **fluid loss** - American Petroleum Institute (API)-13B, *"Section 4, Bentonite"*,

[ ] **marsh funnel** - API-13B, *"Section 4, Field Testing of Oil Mud Viscosity and Gel Strength"*;

[ ] **pinhole dispersion** - ASTM D 4647, *"Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test"*;

[ ] **gradient ratio** - ASTM D 5101, *"Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio"*,

[ ] **hydraulic conductivity ratio** - Draft ASTM D 35 03.91 01, *"Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing"*;

[ ] **hydraulic transmissivity** - ASTM D 4716, *"Standard Test Method for Constant Head Hydraulic Transmissivity (In-plane flow) of Geotextiles and Geotextile Related Products"*;

[ ] **one-dimensional consolidation** - ASTM D 2435, *"Standard Test Method for One-Dimensional Consolidation Properties of Soil"*;

[ ] **one-dimensional swell/collapse** - ASTM D 4546, *"Standard Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils"*;

[ ] **unconfined compressive strength (UCS)** - ASTM D 2166, *" Standard Test Method for Unconfined Compressive Strength of Cohesive Soil"*;

[ ] **triaxial compressive strength ($\overline{\text{ICU}}$)** - ASTM D 4767, *"Standard Test Method for Triaxial Compression Test on Cohesive Soils"*,

[ ] **triaxial compressive strength (UU)** - ASTM D 2850, *"Standard Test Method for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression"*;

[ ] **rigid wall constant head hydraulic conductivity** - ASTM D 2434, *"Standard Test Method for Permeability of Granular Soils (Constant Head)"*;

[X] **flexible wall falling head hydraulic conductivity** - ASTM D 5084, "*Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*";

[ ] **flexible wall falling head hydraulic conductivity** - U. S. Army Corp of Engineers; EM-1110-2-1906, "*Standard Test Method for Permeability Tests, Appendix VII*",

[ ] **index flux of GCL** - proposed ASTM method rough draft # 1, 6/18/94, "*Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter*";

[ ] **flexible wall falling head hydraulic conductivity** - Geosynthetic Research Institute (GRI) GCL-2, "*Standard Test Method for Permeability of Geosynthetic Clay Liners (GCLs)*";

[ ] **permeability/compatibility** - USEPA Method 9100, SW-846, Revision 1, 1987, Standard Test Method for Measurement of "*Saturated Hydraulic Conductivity, Saturated Leachate Conductivity and Intrinsic Permeability*";

[ ] **capillary-moisture** - ASTM D 2325, "*Standard Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus*";

[ ] **capillary-moisture** - ASTM D 3152, "*Standard Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus*" and

[ ] **paint filter liquids** - USEPA Method 9095, SW-846, Revision 1, 1987, "*Paint Filter Liquids Test*"

APPLICATION OF TEST RESULTS

The reported test results apply to the field materials inasmuch as the samples sent to the laboratory for testing are representative of these materials. This report applies only to the materials tested and does not necessarily indicate the quality or condition of apparently identical or similar materials. The testing was performed in accordance with the general engineering standards and conditions reported. The test results are related to the testing conditions used during the testing program. As a mutual protection to the client, the public, and GeoSyntec, this report is submitted and accepted for the exclusive use of the client and upon the condition that this report is not used, in whole or in part, in any advertising, promotional or publicity matter without prior written authorization from GeoSyntec.

APPENDIX C

ANALYTICAL RESULTS

PIT B INVESTIGATION

ECOSYS
LABORATORY SERVICES

ANALYTICAL REPORT

'412 Oakbrook Drive
ıite 105
Norcross, Georgia 30093
Phone 770.368.0636
Fax 770.368.0806

GEOSYNTEC
Neil Davies
1100 Lake Hearn Drive NE
Atlanta, GA 30342
P: 404-705-9500 F: 404-705-9400

Client Code	20112055
Ledger Number	106421
P.O. Number	
Date Received	11/16/95
Time Received	10:10
Reporting Date	12/05/95

Sample Comment *WASTE PROFILE REACTIVITY and IGNITABILITY were performed by a subcontract laboratory. All Non-TCLP Metal Results are provided on a dry weight basis. All other Non-TCLP Results are provided on a wet weight basis.

Lab Sample ID AB22207 **Client Site # / Sample #** **Project #**
Project Name GE3913 BAILEY G-PB-W-1 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOLID OTHER								
˜70	2,4-DINITROTOLUENE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
)	HEXACHLOROBENZENE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	HEXACHLOROBUTADIENE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	HEXACHLOROETHANE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	NITROBENZENE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	PENTACHLOROPHENOL	**$05300**	Below MDL	0.335	mg/L		BS	12/01/95
8270	2,4,5-TRICHLOROPHENOL	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	2,4,6-TRICHLOROPHENOL	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	1,4-DICHLOROBENZENE	**$05300**	Below MDL	0.067	mg/L		BS	12/01/95
8270	CRESOL	**$05300**	0.14	0.067	mg/L		BS	12/01/95
CLP TCL SEMI (GC/MS) SOLID OTHER								
8270	PHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROETHYL) ETHER	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2-CHLOROPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	1,3-DICHLOROBENZENE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	1,4-DICHLOROBENZENE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	1,2-DICHLOROBENZENE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2-METHYLPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROISOPROPYL) ETHER	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	4-METHYLPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	N-NITROSODI-N-PROPYLAMINE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	HEXACHLOROETHANE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
˜0	NITROBENZENE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
. 0	ISOPHORONE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2-NITROPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2,4-DIMETHYLPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROETHOXY)METHANE	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2,4-DICHLOROPHENOL	**$06304**	Below MDL	49500	ug/Kg		BS	11/21/95

Lab Sample ID AB22207 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-1 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TCL SEMI (GC/MS) SOLID OTHER								
8270	1,2,4-TRICHLOROBENZENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	NAPHTHALENE	**S06304**	507000	49500	ug/Kg		BS	11/21/95
8270	4-CHLOROANILINE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	HEXACHLOROBUTADIENE	**S06304**	Below MDL	495000	ug/Kg		BS	11/21/95
8270	4-CHLORO-3-METHYLPHENOL	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2-METHYLNAPHTHALENE	**S06304**	368000	49500	ug/Kg		BS	11/21/95
8270	HEXACHLOROCYCLOPENTADIENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2,4,6-TRICHLOROPHENOL	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2,4,5-TRICHLOROPHENOL	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	2-CHLORONAPHTHALENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2-NITROANILINE	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	DIMETHYL PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	ACENAPHTHYLENE	**S06304**	71200	49500	ug/Kg		BS	11/21/95
8270	2,6-DINITROTOLUENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	3-NITROANILINE	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	ACENAPHTHENE	**S06304**	79400	49500	ug/Kg		BS	11/21/95
8270	2,4-DINITROPHENOL	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	4-NITROPHENOL	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	DIBENZOFURAN	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	2,4-DINITROTOLUENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
	DIETHYL PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	4-CHLOROPHENYL PHENYL ETHER	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	FLUORENE	**S06304**	101000	49500	ug/Kg		BS	11/21/95
8270	4-NITROANILINE	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	4,6-DINITRO-2-METHYLPHENOL	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	N-NITROSODIPHENYLAMINE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	4-BROMOPHENYL PHENYL ETHER	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	HEXACHLOROBENZENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	PENTACHLOROPHENOL	**S06304**	Below MDL	120000	ug/Kg		BS	11/21/95
8270	PHENANTHRENE	**S06304**	238000	49500	ug/Kg		BS	11/21/95
8270	ANTHRACENE	**S06304**	150000	49500	ug/Kg		BS	11/21/95
8270	CARBAZOLE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	DI-N-BUTYL PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	FLUORANTHENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	PYRENE	**S06304**	67800	49500	ug/Kg		BS	11/21/95
8270	BUTYL BENZYL PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	3,3'-DICHLOROBENZIDINE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BENZ(A)ANTHRACENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	CHRYSENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BIS(2-ETHYLHEXYL) PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	DI-N-OCTYL PHTHALATE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BENZO(B)FLUORANTHENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
[illegible]	BENZO(K)FLUORANTHENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
[illegible]	BENZO(A)PYRENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	INDENO(1,2,3-CD)PYRENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	DIBENZ(A,H)ANTHRACENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95
8270	BENZO(G,H,I)PERYLENE	**S06304**	Below MDL	49500	ug/Kg		BS	11/21/95

TCLP VOLATILES SOLID OTHER

8260	VINYL CHLORIDE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
8260	1,1-DICHLOROETHENE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
[illegible]	CHLOROFORM	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
[illegible]	CARBON TETRACHLORIDE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
8260	BENZENE	$07301	1.8	0.1 mg/L	KHO	11/30/95
8260	1,2-DICHLOROETHANE	$07301	0.1	0.01 mg/L	KHO	11/30/95
8260	TRICHLOROETHENE	$07301	0.02	0.010 mg/L	KHO	11/30/95
8260	TETRACHLOROETHENE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
8260	CHLOROBENZENE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95
8260	2-BUTANONE (MEK)	$07301	Below MDL	0.020 mg/L	KHO	11/30/95
8260	PYRIDINE	$07301	Below MDL	0.010 mg/L	KHO	11/30/95

CLP TCL VOC (GC/MS) SOLID OTHER

8260	CHLOROMETHANE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	VINYL CHLORIDE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	BROMOMETHANE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	CHLOROETHANE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	1,1-DICHLOROETHENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	ACETONE	$08304	Below MDL	125000 ug/Kg	KD	12/21/95
8260	METHYLENE CHLORIDE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	CARBON DISULFIDE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,1-DICHLOROETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	2-BUTANONE (MEK)	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,2-DICHLOROETHENE (TOTAL)	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
[illegible]60	1,1,1-TRICHLOROETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
	CHLOROFORM	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	CARBON TETRACHLORIDE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,2-DICHLOROETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	BENZENE	$08304	35000	6250 ug/Kg	KD	12/21/95
8260	TRICHLOROETHENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,2-DICHLOROPROPANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	BROMODICHLOROMETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	2-HEXANONE	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	4-METHYL-2-PENTANONE (MIBK)	$08304	Below MDL	12500 ug/Kg	KD	12/21/95
8260	TRANS-1,3-DICHLOROPROPENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	TOLUENE	$08304	23000	6250 ug/Kg	KD	12/21/95
8260	CIS-1,3-DICHLOROPROPENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,1,2-TRICHLOROETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	TETRACHLOROETHENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	CHLORODIBROMOMETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	CHLOROBENZENE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	ETHYLBENZENE	$08304	86000	6250 ug/Kg	KD	12/21/95
8260	XYLENES (TOTAL)	$08304	52000	6250 ug/Kg	KD	12/21/95
8260	STYRENE	$08304	7600	6250 ug/Kg	KD	12/21/95
8260	BROMOFORM	$08304	Below MDL	6250 ug/Kg	KD	12/21/95
8260	1,1,2,2-TETRACHLOROETHANE	$08304	Below MDL	6250 ug/Kg	KD	12/21/95

WASTE PROFILE REACTIVITY

	REACTIVE CYANIDE (Method 7.3.3.2)	$09610S	Below MDL	25 mg/Kg	*	11/20/95
	REACTIVE SULFIDE (Method 7.3.4.1)	$09610S	360	30 mg/Kg	*	11/20/95

CLP TAL SOLID OTHER

6010	ALUMINUM	$10354	8900	3.7 mg/Kg	JH	12/21/95

Lab Sample ID AB22207 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-1 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TAL SOLID OTHER								
6010	ANTIMONY	$10354	Below MDL	3.0	mg/Kg		JH	12/21/95
6010	ARSENIC	$10354	9.0	6.5	mg/Kg		JH	12/21/95
6010	BARIUM	$10354	940	0.2	mg/Kg		JH	12/21/95
6010	BERYLLIUM	$10354	0.1	0.1	mg/Kg		JH	12/21/95
6010	CADMIUM	$10354	3.4	0.2	mg/Kg		JH	12/21/95
6010	CALCIUM	$10354	11000	10.0	mg/Kg		JH	12/21/95
6010	CHROMIUM	$10354	190	0.7	mg/Kg		JH	12/21/95
6010	COBALT	$10354	8.2	0.5	mg/Kg		JH	12/21/95
6010	COPPER	$10354	105	0.5	mg/Kg		JH	12/21/95
6010	IRON	$10354	18000	1.6	mg/Kg		JH	12/21/95
6010	MAGNESIUM	$10354	1900	4.2	mg/Kg		JH	12/21/95
6010	MANGANESE	$10354	170	5.0	mg/Kg		JH	12/21/95
6010	NICKEL	$10354	21	0.7	mg/Kg		JH	12/21/95
6010	POTASSIUM	$10354	1700	4.0	mg/Kg		JH	12/21/95
6010	SELENIUM	$10354	Below MDL	2.6	mg/Kg		JH	12/21/95
6010	SILVER	$10354	1.7	0.4	mg/Kg		JH	12/21/95
6010	SODIUM	$10354	2800	3.7	mg/Kg		JH	12/21/95
6010	THALLIUM	$10354	Below MDL	4.6	mg/Kg		JH	12/21/95
6010	VANADIUM	$10354	18	0.9	mg/Kg		JH	12/21/95
[illegible]	ZINC	$10354	900	1.7	mg/Kg		JH	12/21/95
	LEAD	$10354	220	3.0	mg/Kg		JH	12/21/95
6010	MERCURY TAL	$10354	Below MDL	0.25	mg/Kg		JH	12/21/95
TCLP METALS SOLID OTHER								
6010	ARSENIC	$11300	0.03	0.03	mg/L		JH	11/29/95
6010	BARIUM	$11300	3.10	0.001	mg/L		JH	11/29/95
6010	CADMIUM	$11300	Below MDL	0.001	mg/L		JH	11/29/95
6010	CHROMIUM	$11300	0.028	0.004	mg/L		JH	11/29/95
6010	LEAD	$11300	Below MDL	0.015	mg/L		JH	11/29/95
6010	SELENIUM	$11300	Below MDL	0.015	mg/L		JH	11/29/95
6010	SILVER	$11300	Below MDL	0.002	mg/L		JH	11/29/95
6010	MERCURY TCLP	$11300	Below MDL	0.0005	mg/L		JH	11/29/95
150.1	pH	09003	7.3	NONE	—		CW	12/05/95
1010	WASTE PROFILE IGNITABILITY	09608	>210	----	oF		*	11/22/95

Lab Sample ID AB22208 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-2 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD		TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOLID OTHER								
8270	2,4-DINITROTOLUENE	$05300	Below MDL	0.1	mg/L		BS	12/01/95

Lab Sample ID AB22208 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-2 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOLID OTHER								
8270	HEXACHLOROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	HEXACHLOROBUTADIENE	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	HEXACHLOROETHANE	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	NITROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	PENTACHLOROPHENOL	**$05300**	Below MDL	0.5	mg/L		BS	12/01/95
8270	2,4,5-TRICHLOROPHENOL	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	2,4,6-TRICHLOROPHENOL	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	1,4-DICHLOROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	12/01/95
8270	CRESOL	**$05300**	0.176	0.100	mg/L		BS	12/01/95
CLP TCL SEMI (GC/MS) SOLID OTHER								
8270	PHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROETHYL) ETHER	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2-CHLOROPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	1,3-DICHLOROBENZENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	1,4-DICHLOROBENZENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	1,2-DICHLOROBENZENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2-METHYLPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROISOPROPYL) ETHER	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-METHYLPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
	N-NITROSODI-N-PROPYLAMINE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	HEXACHLOROETHANE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	NITROBENZENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	ISOPHORONE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2-NITROPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4-DIMETHYLPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BIS(2-CHLOROETHOXY)METHANE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4-DICHLOROPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	1,2,4-TRICHLOROBENZENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	NAPHTHALENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-CHLOROANILINE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	HEXACHLOROBUTADIENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-CHLORO-3-METHYLPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2-METHYLNAPHTHALENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	HEXACHLOROCYCLOPENTADIENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4,6-TRICHLOROPHENOL	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4,5-TRICHLOROPHENOL	**$06304**	Below MDL	24000	ug/Kg		BS	11/21/95
8270	2-CHLORONAPHTHALENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2-NITROANILINE	**$06304**	Below MDL	24000	ug/Kg		BS	11/21/95
8270	DIMETHYL PHTHALATE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	ACENAPHTHYLENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,6-DINITROTOLUENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
[illegible]0	3-NITROANILINE	**$06304**	Below MDL	24000	ug/Kg		BS	11/21/95
	ACENAPHTHENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4-DINITROPHENOL	**$06304**	Below MDL	24000	ug/Kg		BS	11/21/95
8_0	4-NITROPHENOL	**$06304**	Below MDL	24000	ug/Kg		BS	11/21/95
8270	DIBENZOFURAN	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95
8270	2,4-DINITROTOLUENE	**$06304**	Below MDL	9900	ug/Kg		BS	11/21/95

Lab Sample ID AB22208 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-2 **Date & Time Sampled** 11/15/95 09:30

EPA HOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS

CLP TCL SEMI (GC/MS) SOLID OTHER

EPA HOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
8270	DIETHYL PHTHALATE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-CHLOROPHENYL PHENYL ETHER	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	FLUORENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-NITROANILINE	$06304	Below MDL	24000	ug/Kg		BS	11/21/95
8270	4,6-DINITRO-2-METHYLPHENOL	$06304	Below MDL	24000	ug/Kg		BS	11/21/95
8270	N-NITROSODIPHENYLAMINE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	4-BROMOPHENYL PHENYL ETHER	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	HEXACHLOROBENZENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	PENTACHLOROPHENOL	$06304	Below MDL	24000	ug/Kg		BS	11/21/95
8270	PHENANTHRENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	ANTHRACENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	CARBAZOLE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	DI-N-BUTYL PHTHALATE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	FLUORANTHENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	PYRENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BUTYL BENZYL PHTHALATE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	3,3'-DICHLOROBENZIDINE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BENZ(A)ANTHRACENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	CHRYSENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
[illegible]70	BIS(2-ETHYLHEXYL) PHTHALATE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
	DI-N-OCTYL PHTHALATE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BENZO(B)FLUORANTHENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BENZO(K)FLUORANTHENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BENZO(A)PYRENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	INDENO(1,2,3-CD)PYRENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	DIBENZ(A,H)ANTHRACENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95
8270	BENZO(G,H,I)PERYLENE	$06304	Below MDL	9900	ug/Kg		BS	11/21/95

TCLP VOLATILES SOLID OTHER

EPA HOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
8260	VINYL CHLORIDE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	1,1-DICHLOROETHENE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	CHLOROFORM	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	CARBON TETRACHLORIDE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	BENZENE	$07301	0.07	0.010	mg/L		KHO	11/30/95
8260	1,2-DICHLOROETHANE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	TRICHLOROETHENE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	TETRACHLOROETHENE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	CHLOROBENZENE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95
8260	2-BUTANONE (MEK)	$07301	Below MDL	0.020	mg/L		KHO	11/30/95
8260	PYRIDINE	$07301	Below MDL	0.010	mg/L		KHO	11/30/95

CLP TCL VOC (GC/MS) SOLID OTHER

EPA HOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
[illegible]0	CHLOROMETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
[illegible]	VINYL CHLORIDE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	BROMOMETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	CHLOROETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	1,1-DICHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	ACETONE	$08304	Below MDL	50000	ug/Kg		KD	11/21/95

Lab Sample ID	AB22208	Client Site # / Sample #		Project #	
Project Name	GE3913 BAILEY G-PB-W-2			Date & Time Sampled	11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TCL VOC (GC/MS) SOLID OTHER								
8260	METHYLENE CHLORIDE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	CARBON DISULFIDE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1-DICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	2-BUTANONE (MEK)	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,2-DICHLOROETHENE (TOTAL)	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,1-TRICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CHLOROFORM	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CARBON TETRACHLORIDE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,2-DICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	BENZENE	$08304	4700	2500	ug/Kg		KD	11/21/95
8260	TRICHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,2-DICHLOROPROPANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	BROMODICHLOROMETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	2-HEXANONE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	4-METHYL-2-PENTANONE (MIBK)	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	TRANS-1,3-DICHLOROPROPENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	TOLUENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CIS-1,3-DICHLOROPROPENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,2-TRICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	TETRACHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
	CHLORODIBROMOMETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CHLOROBENZENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	ETHYLBENZENE	$08304	15000	2500	ug/Kg		KD	11/21/95
8260	XYLENES (TOTAL)	$08304	7400	2500	ug/Kg		KD	11/21/95
8260	STYRENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	BROMOFORM	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,2,2-TETRACHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
WASTE PROFILE REACTIVITY								
	REACTIVE CYANIDE (Method 7.3.3.2)	$09610S	Below MDL	25	mg/Kg		*	11/20/95
	REACTIVE SULFIDE (Method 7.3.4.1)	$09610S	380	30	mg/Kg		*	11/20/95
CLP TAL SOLID OTHER								
6010	ANTIMONY	$10354	Below MDL	3.0	mg/Kg		JH	11/21/95
6010	ARSENIC	$10354	Below MDL	6.5	mg/Kg		JH	11/21/95
6010	BARIUM	$10354	380	0.2	mg/Kg		JH	11/21/95
6010	BERYLLIUM	$10354	Below MDL	0.1	mg/Kg		JH	11/21/95
6010	CADMIUM	$10354	2.0	0.2	mg/Kg		JH	11/21/95
6010	CALCIUM	$10354	19000	10.0	mg/Kg		JH	11/21/95
6010	CHROMIUM	$10354	160	0.7	mg/Kg		JH	11/21/95
6010	COBALT	$10354	6.1	0.5	mg/Kg		JH	11/21/95
6010	COPPER	$10354	130	0.5	mg/Kg		JH	11/21/95
	IRON	$10354	33000	1.6	mg/Kg		JH	11/21/95
	MAGNESIUM	$10354	3000	4.2	mg/Kg		JH	11/21/95
6010	MANGANESE	$10354	270	5.0	mg/Kg		JH	11/21/95
6010	NICKEL	$10354	22	0.7	mg/Kg		JH	11/21/95
6010	POTASSIUM	$10354	1700	4.0	mg/Kg		JH	11/21/95
6010	SELENIUM	$10354	Below MDL	2.6	mg/Kg		JH	11/21/95

Lab Sample ID AB22208 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-2 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TAL SOLID OTHER								
6010	SILVER	**$10354**	1.1	0.4	mg/Kg		JH	11/21/95
6010	SODIUM	**$10354**	5400	3.7	mg/Kg		JH	11/21/95
6010	THALLIUM	**$10354**	Below MDL	4.6	mg/Kg		JH	11/21/95
6010	VANADIUM	**$10354**	20	0.9	mg/Kg		JH	11/21/95
6010	ZINC	**$10354**	600	1.7	mg/Kg		JH	11/21/95
6010	ALUMINUM	**$10354**	7200	3.7	mg/Kg		JH	11/21/95
6010	MERCURY TAL	**$10354**	Below MDL	0.25	mg/Kg		JH	11/21/95
TCLP METALS SOLID OTHER								
6010	ARSENIC	**$11300**	0.04	0.03	mg/L		JH	11/29/95
6010	BARIUM	**$11300**	2.90	0.001	mg/L		JH	11/29/95
6010	CADMIUM	**$11300**	0.002	0.001	mg/L		JH	11/29/95
6010	CHROMIUM	**$11300**	0.080	0.004	mg/L		JH	11/29/95
6010	LEAD	**$11300**	Below MDL	0.015	mg/L		JH	11/29/95
6010	SELENIUM	**$11300**	Below MDL	0.015	mg/L		JH	11/29/95
6010	SILVER	**$11300**	Below MDL	0.002	mg/L		JH	11/29/95
6010	MERCURY	**$11300**	Below MDL	0.0005	mg/L		JH	11/29/95
[illegible]	pH	**09003**	7.0	NONE	—		CW	12/05/95
1010	WASTE PROFILE IGNITABILITY	**09608**	>210	----	oF		*	11/22/95

Lab Sample ID AB22209 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-3 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOIL								
8270	CRESOL	**$05000**	0.2	0.1	mg/L		BS	11/30/95
TCLP SEMI SOLID OTHER								
8270	2,4-DINITROTOLUENE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
8270	HEXACHLOROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
8270	HEXACHLOROBUTADIENE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
8270	HEXACHLOROETHANE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
8270	NITROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
8270	PENTACHLOROPHENOL	**$05300**	Below MDL	0.5	mg/L		BS	11/30/95
8270	2,4,5-TRICHLOROPHENOL	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
[illegible]	2,4,6-TRICHLOROPHENOL	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
	1,4-DICHLOROBENZENE	**$05300**	Below MDL	0.1	mg/L		BS	11/30/95
TCLP VOLATILES SOLID OTHER								
8260	VINYL CHLORIDE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	1,1-DICHLOROETHENE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95

Lab Sample ID AB22209 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-3 **Date & Time Sampled** 11/15/95 09:30

EPA HOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP VOLATILES SOLID OTHER								
8260	CHLOROFORM	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CARBON TETRACHLORIDE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	BENZENE	$07301	0.15	0.01	mg/L		KHO	12/01/95
8260	1,2-DICHLOROETHANE	$07301	0.10	0.01	mg/L		KHO	12/01/95
8260	TRICHLOROETHENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	TETRACHLOROETHENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CHLOROBENZENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	2-BUTANONE (MEK)	$07301	Below MDL	0.20	mg/L		KHO	12/01/95
8260	PYRIDINE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
WASTE PROFILE REACTIVITY								
	REACTIVE CYANIDE (Method 7.3.3.2)	$09610S	Below MDL	25	mg/Kg		*	11/20/95
	REACTIVE SULFIDE (Method 7.3.4.1)	$09610S	300	30	mg/Kg		*	11/20/95
TCLP METALS SOLID OTHER								
6010	ARSENIC	$11300	Below MDL	0.03	mg/L		JH	11/29/95
6010	BARIUM	$11300	1.10	0.001	mg/L		JH	11/29/95
6010	CADMIUM	$11300	Below MDL	0.001	mg/L		JH	11/29/95
6010	CHROMIUM	$11300	Below MDL	0.004	mg/L		JH	11/29/95
[illegible]0	LEAD	$11300	Below MDL	0.015	mg/L		JH	11/29/95
	SELENIUM	$11300	Below MDL	0.015	mg/L		JH	11/29/95
6010	SILVER	$11300	Below MDL	0.002	mg/L		JH	11/29/95
6010	MERCURY	$11300	Below MDL	0.0005	mg/L		JH	11/29/95
150.1	pH	09003	6.9	NONE	---		CW	12/05/95
1010	WASTE PROFILE IGNITABILITY	09608	>210	----	oF		*	11/22/95

Lab Sample ID AB22210 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-4 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD		TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOLID OTHER								
8270	2,4-DINITROTOLUENE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	HEXACHLOROBENZENE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	HEXACHLOROBUTADIENE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	HEXACHLOROETHANE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
[illegible]70	NITROBENZENE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
	PENTACHLOROPHENOL	$05300	Below MDL	5.0	mg/L		BS	12/01/95
8270	2,4,5-TRICHLOROPHENOL	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	2,4,6-TRICHLOROPHENOL	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	1,4-DICHLOROBENZENE	$05300	Below MDL	1.0	mg/L		BS	12/01/95
8270	CRESOL	$05300	Below MDL	0.1	mg/L		BS	12/01/95

CLP TCL SEMI (GC/MS) SOLID OTHER

8270	PHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	BIS(2-CHLOROETHYL) ETHER	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
	2-CHLOROPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
70	1,3-DICHLOROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	1,4-DICHLOROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	1,2-DICHLOROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2-METHYLPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	BIS(2-CHLOROISOPROPYL) ETHER	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	4-METHYLPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	N-NITROSODI-N-PROPYLAMINE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	HEXACHLOROETHANE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	NITROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	ISOPHORONE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2-NITROPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2,4-DIMETHYLPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	BIS(2-CHLOROETHOXY)METHANE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2,4-DICHLOROPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	1,2,4-TRICHLOROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	NAPHTHALENE	$06304	193000	49500 ug/Kg	BS	11/22/95
8270	4-CHLOROANILINE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	HEXACHLOROBUTADIENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	4-CHLORO-3-METHYLPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2-METHYLNAPHTHALENE	$06304	150000	49500 ug/Kg	BS	11/22/95
8270	HEXACHLOROCYCLOPENTADIENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
70	2,4,6-TRICHLOROPHENOL	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
	2,4,5-TRICHLOROPHENOL	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	2-CHLORONAPHTHALENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2-NITROANILINE	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	DIMETHYL PHTHALATE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	ACENAPHTHYLENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2,6-DINITROTOLUENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	3-NITROANILINE	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	ACENAPHTHENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2,4-DINITROPHENOL	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	4-NITROPHENOL	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	DIBENZOFURAN	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	2,4-DINITROTOLUENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	DIETHYL PHTHALATE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	4-CHLOROPHENYL PHENYL ETHER	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	FLUORENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	4-NITROANILINE	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	4,6-DINITRO-2-METHYLPHENOL	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	N-NITROSODIPHENYLAMINE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	4-BROMOPHENYL PHENYL ETHER	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	HEXACHLOROBENZENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	PENTACHLOROPHENOL	$06304	Below MDL	120000 ug/Kg	BS	11/22/95
8270	PHENANTHRENE	$06304	136000	49500 ug/Kg	BS	11/22/95
	ANTHRACENE	$06304	161000	49500 ug/Kg	BS	11/22/95
	CARBAZOLE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	DI-N-BUTYL PHTHALATE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	FLUORANTHENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	PYRENE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95
8270	BUTYL BENZYL PHTHALATE	$06304	Below MDL	49500 ug/Kg	BS	11/22/95

Lab Sample ID AB22210 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-4 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TCL SEMI (GC/MS) SOLID OTHER								
8270	3,3'-DICHLOROBENZIDINE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BENZ(A)ANTHRACENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	CHRYSENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BIS(2-ETHYLHEXYL) PHTHALATE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	DI-N-OCTYL PHTHALATE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BENZO(B)FLUORANTHENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BENZO(K)FLUORANTHENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BENZO(A)PYRENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	INDENO(1,2,3-CD)PYRENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	DIBENZ(A,H)ANTHRACENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
8270	BENZO(G,H,I)PERYLENE	$06304	Below MDL	49500	ug/Kg		BS	11/22/95
TCLP VOLATILES SOLID OTHER								
8260	VINYL CHLORIDE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	1,1-DICHLOROETHENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CHLOROFORM	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CARBON TETRACHLORIDE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	BENZENE	$07301	0.44	0.01	mg/L		KHO	12/01/95
8260	1,2-DICHLOROETHANE	$07301	0.42	0.01	mg/L		KHO	12/01/95
[illegible]	TRICHLOROETHENE	$07301	0.043	0.01	mg/L		KHO	12/01/95
[illegible]	TETRACHLOROETHENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CHLOROBENZENE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
8260	2-BUTANONE (MEK)	$07301	Below MDL	0.02	mg/L		KHO	12/01/95
8260	PYRIDINE	$07301	Below MDL	0.01	mg/L		KHO	12/01/95
CLP TCL VOC (GC/MS) SOLID OTHER								
8260	CHLOROMETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	VINYL CHLORIDE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	BROMOMETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	CHLOROETHANE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	1,1-DICHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	ACETONE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	METHYLENE CHLORIDE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CARBON DISULFIDE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1-DICHLOROETHANE	$08304	16000	2500	ug/Kg		KD	11/21/95
8260	2-BUTANONE (MEK)	$08304	22000	2500	ug/Kg		KD	11/21/95
8260	1,2-DICHLOROETHENE (TOTAL)	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,1-TRICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CHLOROFORM	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CARBON TETRACHLORIDE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,2-DICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	BENZENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
[illegible]	TRICHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
[illegible]	1,2-DICHLOROPROPANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	BROMODICHLOROMETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	2-HEXANONE	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	4-METHYL-2-PENTANONE (MIBK)	$08304	Below MDL	5000	ug/Kg		KD	11/21/95
8260	TRANS-1,3-DICHLOROPROPENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95

Lab Sample ID	AB22210	Client Site # / Sample #		Project #	
Project Name	GE3913 BAILEY G-PB-W-4		Date & Time Sampled	11/15/95	09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
CLP TCL VOC (GC/MS) SOLID OTHER								
8260	TOLUENE	$08304	19000	2500	ug/Kg		KD	11/21/95
8260	CIS-1,3-DICHLOROPROPENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,2-TRICHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	TETRACHLOROETHENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CHLORODIBROMOMETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	CHLOROBENZENE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	ETHYLBENZENE	$08304	48000	2500	ug/Kg		KD	11/21/95
8260	XYLENES (TOTAL)	$08304	29000	2500	ug/Kg		KD	11/21/95
8260	STYRENE	$08304	40000	2500	ug/Kg		KD	11/21/95
8260	BROMOFORM	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
8260	1,1,2,2-TETRACHLOROETHANE	$08304	Below MDL	2500	ug/Kg		KD	11/21/95
WASTE PROFILE REACTIVITY								
	REACTIVE CYANIDE (Method 7.3.3.2)	$09610S	Below MDL	25	mg/Kg		*	11/20/95
	REACTIVE SULFIDE (Method 7.3.4.1)	$09610S	740	30	mg/Kg		*	11/20/95
CLP TAL SOLID OTHER								
6010	ALUMINUM	$10354	3600	3.7	mg/Kg		JH	11/21/95
6010	ANTIMONY	$10354	Below MDL	3.0	mg/Kg		JH	11/21/95
6010	ARSENIC	$10354	Below MDL	6.5	mg/Kg		JH	11/21/95
	BARIUM	$10354	180	0.2	mg/Kg		JH	11/21/95
6010	BERYLLIUM	$10354	0.4	0.1	mg/Kg		JH	11/21/95
6010	CADMIUM	$10354	0.5	0.2	mg/Kg		JH	11/21/95
6010	CALCIUM	$10354	1400	10.0	mg/Kg		JH	11/21/95
6010	CHROMIUM	$10354	27	0.7	mg/Kg		JH	11/21/95
6010	COBALT	$10354	8.2	0.5	mg/Kg		JH	11/21/95
6010	COPPER	$10354	33	0.5	mg/Kg		JH	11/21/95
6010	IRON	$10354	10200	1.6	mg/Kg		JH	11/21/95
6010	MAGNESIUM	$10354	1200	4.2	mg/Kg		JH	11/21/95
6010	MANGANESE	$10354	210	5.0	mg/Kg		JH	11/21/95
6010	NICKEL	$10354	18	0.7	mg/Kg		JH	11/21/95
6010	POTASSIUM	$10354	560	4.0	mg/Kg		JH	11/21/95
6010	SELENIUM	$10354	Below MDL	2.6	mg/Kg		JH	11/21/95
6010	SILVER	$10354	Below MDL	0.4	mg/Kg		JH	11/21/95
6010	SODIUM	$10354	1000	3.7	mg/Kg		JH	11/21/95
6010	THALLIUM	$10354	Below MDL	4.6	mg/Kg		JH	11/21/95
6010	VANADIUM	$10354	8.0	0.9	mg/Kg		JH	11/21/95
6010	ZINC	$10354	170	1.7	mg/Kg		JH	11/21/95
6010	LEAD	$10354	66	3.0	mg/Kg		JH	11/21/95
6010	MERCURY TAL	$10354	Below MDL	0.25	mg/Kg		JH	11/21/95
TCLP METALS SOLID OTHER								
[illegible]	ARSENIC	$11300	Below MDL	0.03	mg/L		JH	11/29/95
	BARIUM	$11300	1.80	0.001	mg/L		JH	11/29/95
6010	CADMIUM	$11300	Below MDL	0.001	mg/L		JH	11/29/95
6010	CHROMIUM	$11300	0.030	0.004	mg/L		JH	11/29/95
6010	LEAD	$11300	0.019	0.015	mg/L		JH	11/29/95
6010	SELENIUM	$11300	Below MDL	0.015	mg/L		JH	11/29/95

Lab Sample ID AB22210 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-4 **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP METALS SOLID OTHER								
6010	SILVER	**$11300**	Below MDL	0.002	mg/L		JH	11/29/95
6010	MERCURY	**$11300**	Below MDL	0.0005	mg/L		JH	11/29/95
150.1	pH	**09003**	5.4	NONE	—		CW	12/05/95
1010	WASTE PROFILE IGNITABILITY	**09608**	>210	----	oF		*	11/22/95

Lab Sample ID AB22211 **Client Site # / Sample #** **Project #**

Project Name GE3913 BAILEY G-PB-W-1-DUP **Date & Time Sampled** 11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP SEMI SOLID OTHER								
8270	CRESOL	**$05300**	1.11	1.0	mg/L		BS	12/01/95
8270	2,4-DINITROTOLUENE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
70	HEXACHLOROBENZENE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
	HEXACHLOROBUTADIENE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
8270	HEXACHLOROETHANE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
8270	NITROBENZENE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
8270	PENTACHLOROPHENOL	**$05300**	Below MDL	5.0	mg/L		BS	12/01/95
8270	2,4,5-TRICHLOROPHENOL	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
8270	2,4,6-TRICHLOROPHENOL	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
8270	1,4-DICHLOROBENZENE	**$05300**	Below MDL	1.0	mg/L		BS	12/01/95
TCLP VOLATILES SOLID OTHER								
8260	BENZENE	**$07301**	3.0	0.1	mg/L		KHO	12/01/95
8260	1,2-DICHLOROETHANE	**$07301**	0.5	0.1	mg/L		KHO	12/01/95
8260	TRICHLOROETHENE	**$07301**	0.01	0.01	mg/L		KHO	12/01/95
8260	TETRACHLOROETHENE	**$07301**	0.018.	0.01	mg/L		KHO	12/01/95
8260	CHLOROBENZENE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	2-BUTANONE (MEK)	**$07301**	0.022	0.02	mg/L		KHO	12/01/95
8260	PYRIDINE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	VINYL CHLORIDE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	1,1-DICHLOROETHENE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CHLOROFORM	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
8260	CARBON TETRACHLORIDE	**$07301**	Below MDL	0.01	mg/L		KHO	12/01/95
TCLP METALS SOLID OTHER								
0	ARSENIC	**$11300**	Below MDL	0.03	mg/L		JH	11/29/95
	BARIUM	**$11300**	1.60	0.001	mg/L		JH	11/29/95
6010	CADMIUM	**$11300**	0.001	0.001	mg/L		JH	11/29/95
6010	CHROMIUM	**$11300**	0.018	0.004	mg/L		JH	11/29/95
6010	LEAD	**$11300**	Below MDL	0.015	mg/L		JH	11/29/95
6010	SELENIUM	**$11300**	Below MDL	0.015	mg/L		JH	11/29/95

Lab Sample ID	AB22211	Client Site # / Sample #	Project #	
Project Name	GE3913 BAILEY	G-PB-W-1-DUP	Date & Time Sampled	11/15/95 09:30

EPA METHOD	ANALYTE	TEST CODE	RESULT	MDL	UNITS	CAS #	ANALYST	DATE OF ANALYSIS
TCLP METALS SOLID OTHER								
6010	SILVER	$11300	Below MDL	0.002	mg/L		JH	11/29/95
6010	MERCURY TCLP	$11300	Below MDL	0.0005	mg/L		JH	11/29/95

Certifying Scientist

Organics and Inorganics in Wastewater, Solids, and Wastes

NC-DEHNR 441, SC-DHEC 98013, GA, TN-DOH 02826, UT-DOH E-228, FL-DEP 940134, NY-DEH ELAP 11551

Radioactive Materials License	ISO 9000	EPA ID	EPA Reg Waste	GA APHIS	Fed Lab ID	US Army Corps of Engineers Validation
GA-DNR 1283-1	A2LA:0594-01	GA-00058	GA-0001011006	S-3966	58-188334	

GEOSYNTEC
1100 Lakehearn Drive, NE. Suite 200-E
Atlanta, GA 30342
Neil Davies Client ID 20112055

CHAIN OF COUSTODY

Laboratory Services
of EcoSys, Inc.
1412 Oakbrook Drive, Suite 105
Norcross, Georgia 30093
Phone 404•368•0636
Fax 404•368•0806

Project Name: BAILEY

Copy To: R. Neil Davies

Sampler: MARY REDICAN (Name - Please Print or Type)
Signature: Mary Redican

Project #: GE 3913

PO#/Bid#:

Due Date: WILL CALL — STAT ☐

☐ Replacement Sampling Materials?
☐ Fax Report? (name)
Fax #

For test code refer to the EcoSys list of Analyses.

EcoSys Test Code: RCI / TCLP VOCs / TCLP SVOCs/METALS / TAL SVOCs/METALS / TCL VOCs - HOLD

11/22 11/30

Lab code - For Lab use only	Date	Time	Grab	Comp	Site Code/ Sample Number	Number of Containers	RCI	TCLP VOCs	TCLP SVOCs/METALS	TAL SVOCs/METALS	TCL VOCs - HOLD			Remarks
AE 22207	15 NOV 95	0930	X		G-PB-W-1	~~4~~ 5	X	X	X	X	X			PIT B 7 FEET ~~HOLD~~ TCL/TAL ANALYSIS
AE 22208	15 NOV 95	0930	X		G-PB-W-2	5	X	X	X	X	X			PIT B 6-FEET ~~HOLD~~ TCL/TAL ANALYSIS
AE 22209	15 NOV 95	0930	X		G-PB-W-3	3	X	X	X					PIT B 4-FEET ~~HOLD TCL/TAL ANALYSIS~~
AE 22210	15 NOV 95	0930	X		G-PB-W-4	5	X	X	X	X	X			PIT B 7-FEET ~~HOLD~~ TCL/TAL ANALYSIS
AE 22211	15 NOV 95	0930	X		G-PB-W-1-DUP	~~2~~ 2		X	X					PIT B
														... per [illegible] 11/30

HOLD HOLD

Samples Relinquished by:	Date/Time	Samples Received by:	Date/Time
Mary Redican (signature)	15 NOV 95 / 1503	[signature]	11/16/95 / 10:10
Relinquished by:	/	Received by:	/
Relinquished by:	/	Received by:	/

HELD: RELEASED:
QC LEVEL 1 2 (3) 4
☐ DRINKING WATER ☐ WASTE WATER ☐ OTHER
ICE Y☒ N☐ TEMP 4°C
CUSTODY SEAL Y☐ N☒ PH N/A
SAMPLE CONDITION OK
Remarks at Time of Receipt:

Custody Seal? Y☐ N☒ | Entered into LIMS: [initials] | COC Reviewed by: [initials] | Storage Location: G2 | Ledger Number: 106421 prepared for

United States Environmental Protection Agency

Region 6
1445 Ross Avenue
Dallas, Texas 75202

TECHNICAL MEMORANDUM SUPPLEMENTAL

NORTH DIKE AREA

SITE INVESTIGATION AND EVALUATION OF ORIGINAL REMEDY

BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS

submitted by

Bailey Site Settlors Committee

prepared by

GEOSYNTEC CONSULTANTS

1100 Lake Hearn Drive, NE, Suite 200
Atlanta, Georgia 30342

Project Number GE3913-04
October 1995

Prepared for

United States Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202

TECHNICAL MEMORANDUM SUPPLEMENTAL NORTH DIKE AREA SITE INVESTIGATION AND EVALUATION OF ORIGINAL REMEDY

BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS

Submitted by

Bailey Site Settlors Committee

Prepared by

GEOSYNTEC CONSULTANTS
1100 Lake Hearn Drive, NE, Suite 200
Atlanta, Georgia 30342

Project Number GE3913-04

October 1995

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EXECUTIVE SUMMARY

This document has been prepared by GeoSyntec Consultants, Atlanta, Georgia (GeoSyntec), on behalf of the Bailey Site Settlors Committee (BSSC) to present the data obtained from supplemental site investigation activities in the North Dike Area of the Bailey Superfund Site, located in Orange County, Texas. This work product is the result of Task 4 "*Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy*" of the Focused Feasibility Study (FFS) Work Plan, Revision 1, prepared by GeoSyntec for the BSSC and dated 15 August 1995.

The supplemental site investigation was performed to better define the composition and nature of the waste material in the North Dike Area. Previous investigations and studies did not sufficiently characterize these materials for an evaluation of the technical feasibility of solidification/stabilization technologies (i.e., waste component types, particle size, heterogeneity, and presence of solidification inhibitors).

The field work consisted of excavating twelve test pits in the North Dike Area. The excavation of each test pit was carefully logged and documented to provide an estimation of the gross composition of the wastes. Bulk samples were obtained at several depths from each test pit. The bulk samples were hand sorted and sieved to estimate the composition and particle size distribution of the smaller waste fractions.

Laboratory testing consisted of testing of selected waste samples for loss on ignition in order to estimate the percentage of organic material in the waste. Soil samples taken from beneath the waste were also tested to evaluate certain physical properties that will be used in the evaluation of alternative remedies.

Based on the results of the field investigations and laboratory testing, GeoSyntec concludes that a variety of municipal and industrial wastes were co-disposed in the North Dike Area. These wastes include a high proportion of large items of debris and have a high organic content (4% to 51% as determined by loss on ignition). This conclusion is significant since USEPA and industry recognize the infeasibility of stabilizing municipal waste, wastes containing a high proportion of debris, and wastes that have a high organic content.

GeoSyntec also evaluated the solidification component of the original remedy in accordance with the screening process presented in "*Stabilization/Solidification of*

CERCLA and RCRA Wastes" [EPA/625/6-89/022]. Based on this evaluation, solidification of the North Dike Area wastes is not technically feasible because engineering solutions are not viable for the removal of problematic waste components.

GeoSyntec has reviewed several documents that establish USEPA's position with respect to the stabilization of problematic wastes. The presumptive remedy directive "*Presumptive Remedy for CERCLA Municipal Landfill Sites*" [EPA 540-F-93-035] indicates that USEPA recognizes the difficulties associated with the treatment of municipal wastes because of the size and heterogeneity of the waste components. USEPA also recognizes that *"organics typically interfere with the conventional stabilization processes, particularly at concentrations exceeding 1% TOC"* [40 CFR, June 1990, page 22568]. These documents further support GeoSyntec's conclusion that solidification of the North Dike Area wastes is technically infeasible due to the type, size, and heterogeneity of the waste components in that area.

Based on the additional data obtained during the supplemental site investigations, GeoSyntec's evaluation of the solidification component of the original remedy, and the findings presented in this report, GeoSyntec concludes the following:

- solidification of the entire North Dike Area is technically infeasible and should be eliminated from further consideration;
- solidification of certain "hot spots" or localized areas of the North Dike Area may be appropriate if is it evaluated to be necessary as a component of the revised remedy; the practice of isolating or providing special measures for "hot spot" areas is consistent with presumptive remedy directives for CERCLA municipal landfill sites; and
- if solidification is used as a component of a revised remedy for "hot spot" areas, the performance requirements should be evaluated and amended; new performance requirements should be developed that are both implementable and consistent with the engineering requirements of the revised remedy.

1. INTRODUCTION

1.1 Terms of Reference

This document has been prepared by GeoSyntec Consultants, Atlanta, Georgia (GeoSyntec) on behalf of the Bailey Site Settlors Committee (BSSC) to present the results of the supplemental site investigation activities performed in the North Dike Area of the Bailey Superfund Site, located in Orange County, Texas. This work product is the result of Task 4 "*Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy*" of the Focused Feasibility Study (FFS) Work Plan, Revision 1, prepared by GeoSyntec for the BSSC and dated 15 August 1995. The FFS Work Plan was submitted to the U.S. Environmental Protection Agency (USEPA), Region 6, on 15 August 1995. USEPA provided the BSSC with approval to proceed with the Work Plan on 16 August 1995.

Work was performed as outlined in the approved FFS Work Plan, and in accordance with the specific requirements of the following documents:

- Sampling and Analysis Plan for Supplemental Site Investigation for Focused Feasibility Study, Revision 1, (SAPSSI) dated 17 August 1995, and prepared by GeoSyntec;

- Quality Assurance Project Plan (QAPP) prepared by Harding Lawson Associates (HLA), dated October 1991, as amended by Appendix A of the SAPSSI;

- Final Sampling and Analysis Plan (SAP-HLA) prepared by HLA, dated October 1991; and

- Health and Safety Plan (HASP) prepared by Parsons Engineering Science, Inc. (Parsons ES), dated July 1995, and Addenda Number 1 and 2.

1.2 Project Background

The Bailey Superfund Site is located approximately three miles (five km) southwest of Bridge City in Orange County, Texas. The site was originally part of a tidal marsh near the confluence of the Neches River and Sabine Lake. In the early 1950s, Mr. Joe Bailey constructed two ponds (Pond A and Pond B) at the site as part of the Bailey Fish Camp. The ponds were reportedly constructed by dredging the marsh and piling sediments to form dikes along the north and east limits of Pond A (the North Dike Area and the East Dike Area). Between the time of construction (1950s) and the spring of 1971, Mr. Bailey used a variety of wastes (including industrial wastes, municipal solid waste, and construction debris) as fill material for these dikes.

In 1984, the USEPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986. A remedial investigation (RI) was completed for the site in October 1987, and a feasibility study (FS) was completed in April 1988. The RI concluded that: (i) the site has had no impact on drinking water; and (ii) in the unlikely event that any constituents were to migrate in the direction of ground water flow, it would take over 800 years for them to reach potable ground water. The shallow ground water beneath and adjacent to the site is saline and not suitable for human consumption. The closest public water supply well, located approximately 1.5 miles (2.4 km) northeast of the site, is estimated to be approximately 385 ft (117 m) deep. The nearest municipal water supply wells are located approximately 2.6 miles (4.2 km) northeast of the site and have a reported depth of approximately 585 ft (173 m). There has been no development in the project area, nor is it likely to be suitable for future development due to prohibitions against development in wetlands areas. No air emissions above ambient conditions were detected during air monitoring activities conducted during RI field activities.

The FS recommended in-situ solidification of the on-site waste as the preferred remedy for the site. USEPA selected this remedy in its Record of Decision (ROD), signed on 28 June 1988. The remediation area comprises the North Dike Area, East Dike Area, and the North Marsh Area. The North Dike Area is approximately 3,000 ft (914 m) long by 130 ft (40 m) wide, and the East Dike Area is approximately 1,200 ft (366 m) long by 220 ft (67 m) wide. Surficial tarry wastes are present in the North Marsh Area which borders the north side of the North Dike Area. These wastes extend from the edge of the North Dike Area to a distance of up to 150 ft (46 m) into the marsh.

A remedial design (RD) for the above remedy was developed by Harding Lawson Associates, Houston, Texas (HLA) and a construction contract for the implementation of the remedial action (RA) was awarded to Chemical Waste Management, Inc. (Chem Waste) in 1992. During initial attempts to solidify waste in the East Dike Area, Chem Waste encountered numerous difficulties attaining the specified performance parameters for the solidified waste. As a result of the difficulties, the RA was eventually suspended in early 1994. Remedial activities that were completed prior to the cessation of work include the construction of the dike around the East Dike Area of the site, and partial solidification of waste within that area.

After Chem Waste stopped work, the BSSC retained independent contractors and consultants to perform a pilot study to evaluate the feasibility of the selected remedy (i.e., in-situ solidification) at one location in the East Dike Area. The study indicated that solidification could be performed at that location in general conformance with the specifications. The study concluded, however, that to meet the specification requirements, conformance testing needed to be based on wet sampling of uncured material, followed by laboratory curing, rather than coring of material cured in-situ (as had initially been performed). Importantly, the study did not address the feasibility of solidification in other areas of the site. Data and information collected during the RA indicates that the waste in the North Dike Area is deeper and more heterogeneous than the waste in the area of the pilot study. Data obtained during the RA also indicates that waste constituents in the North Dike Area include municipal waste, rubber crumb, and tarry wastes which, based on both USEPA and industry experience, may be difficult and expensive to effectively solidify in-situ. If present in sufficient quantities, these constituents could render in-situ solidification technically infeasible.

Based on RA activities at the site to date, the BSSC concluded that successful site-wide solidification of waste at the site would be, at a minimum, expensive, time consuming, and difficult to implement. Solidification in accordance with the specifications may be technically infeasible in the North Dike Area. Recognizing this fact, USEPA requested that the BSSC further evaluate the feasibility of solidification of the North Dike Area and perform an FFS to identify whether more expedient and effective RA alternatives may be available.

Other reasons for performing the FFS at this time include: (i) developments over the past seven years in the materials and methods used to implement RAs will allow consideration of remedial alternatives not available at the time the original FS was prepared; and (ii) data collected during conduct of the RD and RA have resulted in an improved understanding of subsurface conditions at the site in comparison to the understanding of conditions at the time the original FS was conducted.

1.3 Objectives of the Supplemental Site Investigation

The supplemental site investigation was performed to better define the composition and nature of the waste material in the North Dike Area. Results of the solidification pilot study performed in the East Dike Area indicate that solidification of waste in the North Dike Area may be infeasible due to the composition of waste and its deeper vertical extent in comparison to the East Dike Area waste. The waste composition in the North Dike Area was not well documented, but was reported to contain a higher proportion of tarry materials, municipal solid waste, and rubber crumb than the East Dike Area waste. Effective solidification of all three types of materials could prove difficult, and possibly infeasible. To proceed with the evaluation of the original remedy, and to evaluate potential alternative remedies, it was necessary to better define the composition and nature of the waste material in the North Dike Area.

In the Work Plan for the FFS, it was proposed that a limited number of test pits be excavated in the North Dike Area so that the composition of the disposed waste could be evaluated. The results of the waste composition analysis will be considered during the evaluation of the original remedy, the remedial technology screening process, and the detailed analysis of remedial alternatives. USEPA guidance documents were used to the extent possible to evaluate the feasibility of solidification of waste materials identified through the composition evaluation. This document presents the findings of the supplemental site investigation together with an evaluation of the technical feasibility of in-situ solidification as a remedy for the North Dike Area of the site.

2. OVERVIEW OF PREVIOUSLY OBTAINED NORTH DIKE AREA DATA

2.1 Summary of Previous Investigations

This section of the document presents a brief overview of the various investigation activities performed in the North Dike Area of the site. The section is not intended as an all inclusive summary, but is intended to document the main elements of the work performed to date and to identify the data gaps that lead to the performance of the supplemental site investigation described herein.

Remedial Investigation (RI)

As part of the site remedial investigation (RI), Woodward-Clyde Consultants (WCC) advanced numerous borings into the North Dike Area (referred to as the Waste Channel Area in the RI report). The RI indicates that a total of 66 borings were completed of which 12 were "*individual soil/waste borings and 54 borings were traverse borings completed to identify the limit of the waste.*" Section 4.2.2.1 of the RI states:

> "*Wastes deposited in this area consist of both municipal and industrial wastes, which are commonly intermixed. The municipal waste is comprised of fragments of glass, metal and wood, along with miscellaneous rubble and trash. Glass marbles and rusty material were also noted. The industrial wastes are black and of variable consistency, usually granular and crumbly to rubbery. The material varies from very soft to hard. The waste is occasionally tarry in consistency, particularly along traverse RWCT-15. The industrial waste often is intermixed with municipal waste and/or soil fill, and occasionally interlayered with municipal waste and/or soil fill. Also, the waste is sometimes described as oily; typically, this occurs below the level of groundwater saturation. So, the description "oily" likely reflects increased moisture content rather than a different type of waste material.*"

A review of the RI boring logs and other data (Appendix E of the RI) indicates that jar samples of the waste were taken. The boring logs indicate that in some cases, pocket penetrometer shear strength readings and photoionization detector (PID) readings were taken on the samples. However, it appeared that no attempt was made to evaluate the composition of the waste, other than visual classification of boring samples. The emphasis of the investigation appears to have been on defining the extent of the waste materials (horizontal and vertical), and the nature of any contamination resulting from the waste.

Feasibility Study (FS)

Additional field and laboratory activities were performed during the FS by Engineering-Science, Inc. (now Parsons Engineering Science (Parsons ES)). The focus of the FS was on characterizing the waste for purposes of evaluating certain RA alternatives (solidification, landfilling incineration, deep well injection, and wastewater biological treatment). The FS presented data to demonstrate that solidification of the waste reduced the mobility of waste constituents. Data were also presented to demonstrate improvements in the geotechnical properties of the solidified waste as compared to raw waste samples.

For the FS, Parsons ES performed testing on two composite samples that were identified as being representative of the North Dike Area and East Dike Area. According to Appendix E of the FS, each composite sample was made from discrete borings advanced into the two waste disposal areas. The sample from the North Dike Area (designated "BWC") was composed of discrete samples from fifteen 10- to 12-ft (3 to 3.6 m) deep borings in the North Dike Area while the East Dike Area sample (designated "BEA") was comprised of samples from thirteen 10- to 12-ft (3 to 3.6 m) deep borings in the East Dike Area. The FS states that both hollow stem auger and air rotary drilling methods were employed to advance the borings. Shelby tubes were used to collect samples. Where the waste was too wet or oily to collect with Shelby tubes, the waste was collected from drilling cuttings using a hand trowel.

The FS evaluated the effectiveness of solidification by comparing test results for raw waste to several samples of solidified wastes (using different solidification agents and mix proportions). The evaluation was made using data from toxic characteristic leaching procedure (TCLP) testing (USEPA Method 1311) and geotechnical testing. Geotechnical testing consisted of the following:

- paint filter (USEPA Method 9095);
- moisture content (ASTM D 2216);

- liquid and plastic limits (ASTM D 4318);
- bulk density (ASTM D 2922 or D 2937);
- physical description (ASTM D 2488);
- soil pH (USEPA Method 9045);
- optimum moisture and density (ASTM D 558);
- compressive strength (ASTM D 1632, ASTM D 1633);
- wetting-and-drying durability (ASTM D 559 Method B); and
- permeability (ASTM D 3877).

The FS demonstrated that solidification of the waste samples reduced the mobility of the waste constituents (determined by TCLP testing) and improved the geotechnical properties of the material.

Stabilization Evaluation Report (SER)

An in-situ stabilization evaluation program was a requirement of the Consent Decree. A work plan to meet the requirement was developed and then implemented between August and December 1990 by HLA. The objectives of the evaluation were to:

- further characterize the chemical and physical properties of the site;

- define stabilization sectors and the appropriate stabilization admixtures for each sector; and

- estimate the physical and hydrogeological properties of the North Marsh Area levee for use in the design.

The field investigation program consisted of the following:

- drilling and sampling 11 geotechnical borings adjacent to the waste areas to investigate the engineering properties of surrounding soils for design purposes;

- drilling and sampling 18 borings in the waste areas designated in the RI/FS;

- excavating 15 trenches with a backhoe to augment or supplement waste samples obtained from the borings;

- compositing samples from waste borings and trenches for the subsequent laboratory admixture stabilization evaluation;
- performing 15 cone penetration tests (CPT) in the waste areas to evaluate the effectiveness of the cone as a tool to delineate waste boundaries during remediation; additionally, the cone penetrometer was used to collect geotechnical data necessary for design; and
- performing a field audit to see that the procedures outlined in the work plan and QAPP were being followed, and to identify any required modifications to these procedures.

HLA prepared a Stabilization Evaluation Report (SER) describing the results of the in-situ stabilization evaluation program. According to the SER, bulk samples were taken for visual classification and geotechnical laboratory testing. Most of the waste borings were drilled using a track-mounted drill rig and hollow stem augers. Shelby tube, split-spoon, and bucket type samplers were used to obtain samples for logging purposes. Auger cuttings were collected to provide sufficient volume of sample for the admixture stabilization evaluation.

The SER also addressed the thickness of waste in areas of interest. For example:

> "*The waste borings indicated an industrial waste thickness as thin as 0.8 feet at HLA-3 in Pit B and as thick as 10.5 feet at HLA-8 north of Pond A. The average depth of waste along the East Side of Pond A was 5.0 feet....*"

Fifteen trenches were excavated in both the North Dike Area and the East Dike Area. According to the SER, the trenches were performed to provide additional sample volume for the admixture stabilization evaluation program. Waste profile descriptions, PID readings, and pocket penetrometer measurements were also taken during the trenching.

The SER presents the results of a three-phase evaluation procedure performed by HLA. For the Phase I evaluation, physical and chemical properties of the unstabilized waste were evaluated to provide a baseline for comparison with the properties of the stabilized wastes. During Phase I, three admixture types were evaluated at different dosages (cement, flyash and lime kiln dust). Phase I testing was performed using a pocket penetrometer to assess the potential effectiveness of each admixture. Samples that had an unconfined compressive strength (UCS) equal to or greater than approximately 50 psi (344.7 kPa) after curing for 72 hours, as measured with the pocket penetrometer, were selected for the Phase II evaluation. The UCS criteria was apparently established as 25 psi (172.4 kPa) multiplied by an approximate factor of safety of 2.

Phase II of the testing program consisted of confirming the UCS of the samples that passed the Phase I evaluation using a modified form of ASTM D 1633. The goal was to estimate the amount of admixture required to attain a UCS strength of 25 psi (172.4 kPa).

Phase III of the testing program consisted of evaluating physical properties of the stabilized waste including: UCS (after being immersed in the site ground water for 31 days); moisture content; dry density; and permeability. The summary of the admixture evaluation included the following:

> *"In general, it has been found that the waste at the site can be stabilized with an admixture of 10 to 20 percent cement and meet the minimum strength and permeability requirements with a resulting decrease in mobility of a majority of the metals present. Sample Areas 8 and 9*[1] *were better stabilized when treated with lime kiln dust due to their high oil and grease concentrations."*

The SER also included a literature study of stabilization techniques. Techniques evaluated were as follows:

- inject and mix:
  - shallow soil mixing;
  - track mounted mixing;

- pneumatic spreading;

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[1]Sample Area 8 consists of Pit B and the east end of Pit A-3. Sample Area 9 is located east of Pit B.

- closed loop consolidation; and
- excavation/stabilization.

The summary of the literature study included the following:

"The best suited stabilization techniques include inject the mix, and area excavation (excavate, stabilize, and replace). The inject and mix technique is well suited for areas having only small quantities of debris mixed with the waste. Where large amounts of debris are present, area excavation will be required."

2.2 Evaluation of Previous Data and Identification of Data Gaps

The RI report focused on defining the nature and extent of waste present at the site. Identified materials include municipal waste, industrial wastes, rubble, and trash. The RI also indicates the presence of tarry and oil wastes.

The FS focused on the evaluation of potential RA alternatives for the Bailey Superfund Site and included an evaluation of the effectiveness of solidification. Effectiveness was evaluated on the basis of an overall reduction in the mobility of the waste constituents (based on TCLP testing of unsolidified and solidified waste samples), and by improvements to the geotechnical properties (primarily strength and permeability) of the waste.

The in-situ stabilization evaluation program was performed as part of the Remedial Design (RD) effort, and was a requirement of the Consent Decree. The SER presents the findings of the evaluation program. Data gathered during the evaluation program expanded on the FS efforts and was used to support the following:

- evaluation of appropriate admixtures;
- evaluation of in-situ solidification methods;
- evaluation of appropriate QA/QC methods; and
- delineation of various areas of the site that may need special consideration.

An important observation is that all of the above studies were essentially based on samples obtained from borings using split-spoon, Shelby tubes, or small bucket samplers to collect the samples. In some cases, Auger cuttings were added to the samples so that a sufficient amount of material would be available for the stabilization testing. These sampling methods are not effective for collecting samples that contain large-sized waste particles and tarry and liquid wastes. Therefore, the samples had maximum particle sizes on the order of 1 to 2 (2.5 to 5.1 cm) inches in greatest dimension and the sampling methodology would exclude significant portions of debris, municipal solid waste, liquid, and tarry components.

It appears that only limited attempts were made to study or evaluate the physical composition of the waste at a macro-scale (i.e., extent of large items such as debris, cable, wood and metal items that could interfere with in-situ solidification methods). Also, the waste was not adequately evaluated at the micro-scale (i.e., identification of individual components with respect to particle size, percentage composition, and the presence of oil, grease, or other potential solidification inhibitors). A thorough evaluation of both the macro- and micro-composition of the waste is considered to be important with respect to making a complete evaluation of the technical feasibility of in-situ solidification methods. The supplemental site investigation program for the North Dike Area was therefore designed to provide this information.

Also, in evaluating the technical feasibility of the original remedy for the North Dike Area, valuable information can be extrapolated from the efforts that have been made in the East Dike Area of the site. However, it is important to note that previous investigations have concluded that there are significant differences between the North Dike Area and the East Dike Area. Generally, the North Dike Area wastes are deeper than the East Dike Area. Observations also indicate the nature of the waste to be different.

2.3 Previous Remedial Efforts

2.3.1 Overview

As stated above, even though the waste in the North Dike Area differs from the East Dike Area, valuable information can be obtained from a review of previous efforts to solidify the East Dike Area materials. The following sections provide an overview of the previous solidification efforts performed in the East Dike Area and an assessment of the applicability of the available information to the North Dike Area remediation.

2.3.2 Summary of East Dike Area Solidification Efforts

CWM was awarded the construction contract for the implementation of the RA in 1992. This contract included the solidification of both the North Dike Area and the East Dike Area. Numerous difficulties were encountered during the solidification effort that occurred in the southern part of the East Dike Area. This resulted in the suspension of the RA in January 1994, largely due to difficulties in attaining the specified criteria for permeability (measured by testing cores of solidified waste) and strength (measured as UCS). It is important to note that the area of the East Dike that was solidified corresponds approximately to the area referred to as "Sample Area No. 7" in the SER. According to Table 1 of the SER, the waste in the area is described as follows:

"*Black Cindery Waste*
- *saturated, soft*
- *some rubbery chunks, no municipal waste noted*"

Also, according to the waste isopach map (Drawing 2B of the SER), the waste depth in Sample Area No. 7 is typically 3 to 4 ft (0.9 to 1.2 m) deep with localized depressions to approximately 7 ft. (2.1 m). Both the SER and the data obtained from the supplemental site investigation (presented in this report) indicate the North Dike Area to be significantly different with respect to both waste composition and depth.

After the contractor stopped work, the BSSC retained independent contractors and consultants to perform a pilot study. The findings of the pilot study are discussed below.

2.3.3 In-Situ Stabilization Pilot Demonstration

An in-situ pilot demonstration was performed at the Bailey Superfund Site between 19 October and 26 October 1994 (i.e., after suspension of construction activities). The work was performed by independent contractors and consultants, and the findings were presented in a report entitled "*In-Situ Stabilization Pilot Demonstration - Final Report*" [McLaren Hart Environmental Engineering Corporation and Kiber Environmental Services, Inc.].

The executive summary of the report states the following:

"The field work consisted of the in-situ stabilization of two test sections in material which was deemed representative for the waste areas requiring in-situ stabilization. One area was stabilized with a mixture of cement and bentonite and one area with the addition of 20% cement, the minimum amount required in the initial performance-based Technical Specifications. During this field work a variety of QA/QC measures were taken and documented. The stabilized material was subsequently sampled in the uncured (wet sampling) and cured (hardened) state using various methods. The sampling methods were chosen based on general industry practices, the initial Technical Specifications, and based on methods previously utilized at the Site. Samples obtained from these various methods were then sent to Kiber's laboratory in Atlanta, Georgia.

Laboratory testing, consisting primarily of unconfined compressive testing and permeability testing, on the various samples obtained from the pilot demonstration. The results of this testing indicated that the wet samples yielded acceptable test results which met the initial Technical Specifications and were consistent with the test results achieved during the bench-scale treatability study which was performed prior to the field work. The test results from the samples obtained in the cured state using drilling techniques yielded unacceptable test results. Visual observations of these samples indicated that these samples had microfractures which in our opinion are due to disturbance during sampling operations. These findings were consistent with our experience, and the experience of others in this field on similar stabilization projects. Further, additional longer term testing of the wet samples and cured samples showed that the wet sample continued to gain strength with time, while the cured samples showed no significant strength gains with time, an indication that these samples have be sufficiently disturbed after initial curing.

Based on the in-situ pilot demonstrations performed by McLaren/Hart and Kiber, review of the Technical Specifications, the experience of McLaren/Hart, Kiber and others in the industry, we have concluded the following:

- *The waste material can be stabilized to the required depths and areal extent, using in-situ technology and non-propriety admixtures, and;*

- *The waste material can be stabilized such that the stabilized material has a minimum unconfined compressive strength of 25 psi and a maximum permeability of 1 x 10^{-6} cm/sec, consistent with the overall intent of the Contract Documents.*

The above conclusions are based on the using wet sampling methods for Contract acceptance. This would require the approval of a sampling modification in accordance with the Field Order or Change Order process.

It is also the opinion of McLaren/Hart and Kiber that the reproducibility of meeting the Technical Specifications during full-scale work is very good. Based on the above conclusions, it is our opinion that no additional in-situ stabilization pilot studies are necessary for the East Waste Disposal Area."

It is important to note that both pilot demonstration areas (Area A and Area B) were located close to the middle of the East Dike Area. Correlating this back to the SER, the locations were approximately the middle point between "Sample Area No. 2" and "Sample Area No. 7" in the SER. Descriptions of the waste at these locations, as presented in the SER, are as follows:

- Sample Area No. 2
  "Black Cindery Waste
  - *dry, soft*
  - *some municipal waste*
  - *soft with gravel size rubbery waste."*

- Sample Area No. 7
  "Black Cindery Waste
  - *saturated, soft*
  - *some rubbery chunks, no municipal waste noted."*

The waste depth at the pilot demonstration areas (maximum difference between the surface and the bottom of the treatment area) was 7.75 ft. (2.4 m). However, the report is not clear as to whether this is the depth of the waste, or the depth that was treated. A review of the waste isopach map of this area (Drawing 2B of the SER) suggests that the waste depth at the pilot area may only be 3 to 5 ft deep (0.9 to 1.5 m).

2.4 Relevance of Pilot Demonstration to North Dike Area

Data gathered during previous studies, together with the data presented in this report, supports the following observations:

- the principal description of East Dike Area waste (as provided by HLA) is "Black Cindery Waste"; HLA only used this description for wastes at the extreme east end of the North Dike Area; generally, HLA described the North Dike Area wastes as:
  - "Industrial and Municipal Waste" (black cindery and rubbery wastes with boards, trees, tires, and appliances),
  - "Black Rubbery Waste" (with tar-like and cindery layers and large amounts of municipal waste), and
  - "Oily Tar-Like Waste";
- the waste material in the North Dike Area likely contains a greater proportion of municipal solid waste, and larger items of debris than the East Dike Area;
- the North Dike Area contains zones of very oily or tarry waste materials that are significantly different to the East Dike Area wastes; and
- generally, the wastes in the North Dike Area are deeper than the wastes in the East Dike Area; waste depths in the North Dike Area can be greater than 10 ft (3 m), whereas, average waste depths in the East Dike Area are approximately 5.0 ft (1.5 m).

3. INVESTIGATION, SAMPLING AND TESTING PROCEDURES

3.1 Test Pit Excavation and Sampling Procedures

Between 22 and 25 August 1995, 13 test pits (designated G-TP1 through G-TP13) were excavated along the North Dike Area, east of Pit B. Ten of the test pit locations (G-TP1 through G-TP9 and G-TP11) were evenly spaced along this portion of the North Dike Area. The locations for test pits G-TP10, G-TP12, and G-TP13 were selected to provide additional waste composition information. G-TP10 was excavated adjacent to G-TP9 because it was believed that the waste composition for the two adjacent areas could be different. Test pit G-TP9 was excavated in a soft, low-lying area that had oily and tarry waste exposed at the ground surface. Test pit G-TP10 was excavated in an area adjacent to G-TP9 that could support the weight of the backhoe and did not have the oily and tarry waste exposed at the ground surface. Test pit G-TP12 was excavated between G-TP1 and G-TP2, and G-TP13 was excavated between G-TP2 and G-TP3. Test pits G-TP12 and G-TP13 were excavated so that the waste composition in the vicinity of G-TP2 could be better evaluated. The test pit locations are shown on Figure 1.

The test pits were excavated with a backhoe and were approximately 3 to 4 ft (0.9 to 1.2 m) wide, 10 ft (3 m) long, and between 4.5 to 13 ft (1.4 to 4 m) deep. The test pits were excavated to a depth at least 1 ft (0.3 m) below the bottom of the waste, except for G-TP9. Test pit G-TP9 was excavated in an area where the waste material had very little strength; therefore, the test pit walls tended to collapse or flow into the open excavation before the waste could be excavated to a depth of one foot below the bottom of the waste material.

The excavated soil and waste material were placed on plastic sheeting down wind from the excavation. Samples of the waste material and the soil beneath the waste were collected from the backhoe bucket with a shovel as the excavation proceeded. A total of 23 bulk waste samples were placed in 5-gallon (18.5-l) plastic buckets for waste characterization analysis. Duplicate waste samples were collected for 14 of the 23 was samples and were placed in 1-gallon (3.7-l) metal or approximately 1-quart (0.9-l) plastic containers for laboratory analysis. In addition, seven soil samples were collected from beneath the waste for laboratory analysis. A summary of the samples collected from the North Dike Area during this supplemental site investigation is included in Table 1.

The walls of the test pits were logged by field personnel standing along the rim of the excavation. No one was permitted to enter the excavations. Field personnel logged the contents of the excavated material regarding the relative amounts of glass, metal, municipal solid waste (MSW) and soil mixture, rubber crumb and soil mixture, soil, wood, pebbles and stone, organic material, and other waste materials. Photographs were taken and a videotape recording was made during the excavation process. Observations made during the test pit excavation activities are discussed in Section 4.1 of this document.

3.2 Testing Procedures

3.2.1 Field Tests

The temperature of three bulk samples was measured in the field following the placement of the bulk samples in the 5-gallon (18.5-l) plastic buckets. Twenty bulk samples or portions of the bulk samples were characterized in the field to evaluate the waste composition for each sample. The following procedures were used to perform this evaluation:

- the weight and volume of each waste characterization sample were recorded on pre-printed waste characterization forms;
- the sample was sorted by particle size using 14-in. (0.36-m) diameter sieves with square openings of 1 in. (25.4 mm), 1/2 in. (12.7 mm), and 1/4 in. (6.4 mm);
- the material remaining on each sieve and passing the 1/4-in. (6.4 mm) sieve was then sorted according to composition: glass, metal, MSW and soil mixture, rubber crumb and soil mixture, soil, wood, pebbles and stone, organic material, and other waste materials; and

- the weight and volume for each composition type and particle size were recorded on the waste characterization forms.

The results of the field tests are presented in Section 4.2.1 of this document.

3.2.2 Laboratory Tests

The 14 waste duplicate samples and the 7 soil samples collected from beneath the waste were shipped to the GeoSyntec Environmental Laboratory in Atlanta, Georgia, for additional analyses. Nine waste samples were tested for loss on ignition (ASTM D 2947) to estimate organic content, percent passing No. 4 U.S. standard sieve size, and moisture content (ASTM D 2216). Six soil samples were tested for the following:

- percent passing No. 200 U.S. standard sieve size (ASTM D 1140);
- Atterberg limits (ASTM D 4318);
- soil classification (ASTM D 2487); and
- hydraulic conductivity (ASTM D 5084) (only three samples tested).

The results of these laboratory analyses are presented in Section 4.2.2 of this document.

4. INVESTIGATION AND TESTING RESULTS

4.1 Test Pit Observations

The following observations were made during the excavation of each test pit:

- overburden thickness,
- depth to bottom of waste,
- depth to ground water,
- description of soil beneath the waste, and
- depth to bottom of test pit, and
- waste composition (percentages of glass, metal, MSW and soil mixture, rubber crumb and soil mixture, rubbery waste, soil, wood, pebbles and stone, organic material, and other waste materials were estimated).

In general, based on visual observations made during the excavation of the test pits, the waste contained varying amounts of the waste type listed below (approximated maximum percentages for any one test pit are also listed):

- broken and unbroken glass bottles: up to 40 percent (up to 30 percent unbroken bottles);
- paper: up to 10 percent;
- metal: up to 60 percent;
- wood: up to 10 percent;
- decomposed MSW and soil mixture: up to 90 percent;
- rubbery waste: up to 20 percent; and
- rubber crumb and soil mixture: up to 100 percent.

The following waste materials were also observed in the excavated waste material: automobile tires; water heater; 55-gallon (208 l) drums; plywood; metal pipe, wire, and metal pieces greater than 2 ft (0.6 m) square; concrete pieces up to 3 ft (0.9 m) in diameter and 3 to 4 in. (76 to 101 mm) thick; and two animal bones (up to approximately 2 ft (0.6 m) long).

The portions of the waste that contained mainly decomposed MSW and soil were generally dark brown in color. As the percentage of rubber crumb and other oily and tarry waste materials increased, the waste became black in color.

The observations for each test pit together with sample descriptions and photographs of the excavated waste material are included in Appendix A.

4.2 Testing Results

4.2.1 Field Tests

Table 2 summarizes the results of the waste characterization analyses performed on the 20 bulk samples collected from the test pits. The characterized waste samples contained varying amounts of the waste types listed below (maximum weight percentages for any one sample are also listed):

- broken glass: up to 38 percent;
- metal: up to 8 percent;
- wood: up to 5 percent;
- decomposed MSW and soil mixture: up to 100 percent;
- oily tar-like waste: up to 100 percent;
- very oily tar-like material: up to 89 percent;
- rubber crumb and soil mixture: up to 100 percent;
- soil: up to 10 percent (could be separated from the waste);

- pebbles and stones: up to 21 percent;
- other organic material (straw): up to 5 percent; and
- gray to black silty clay with some oily/tar stains: up to 100 percent (soil type typically located beneath the waste.

Figures 2 through 6 present waste composition summary charts for each test pit. The data in Table 2 was used to prepare these charts.

4.2.2 Laboratory Tests

The data report for the laboratory tests is included as Appendix B of this document. As shown in Table 1 of Appendix B, the waste samples had the following characteristics:

- moisture content (ASTM D 2216);
- percent passing No. 4 U.S. standard sieve size: 63.6 to 79.7 percent with an average of 87.3 percent; and
- loss on ignition (ASTM D 2947): 4.0 to 51.2 percent with an average of 23.9 percent.

The results of the soil sampling testing program are presented as Table 2 of Appendix B. The soil samples had the following characteristics:

- percent passing No. 200 U.S. standard sieve size: 64.0 to 99.6 percent with an average of 91.75 percent;
- Atterberg limits (ASTM D 4318): liquid limit—35 to 67 percent with an average of 49.5 percent; plastic limit—17 to 32 percent with an average of 23.3 percent; plasticity index—10 to 43 percent with an average of 26.2;
- soil classification (ASTM D 2487): gravelly silt with sand (sample G-TP5-S-1); fat clay (samples G-TP6-S-1, G-TP12-S-1, and G-TP13-S-1); and lean clay (samples G-TP8-S-1 and G-TP11-S-1); and

- hydraulic conductivity (ASTM D 5084): 3.3×10^{-7} to 1.1×10^{-7} cm/sec.

These results will be used during the evaluation of alternative remedies, and are therefore not addressed further in this document.

5. INTERPRETATION OF RESULTS

5.1 Summary of Waste Composition in the North Dike

As shown on Figure 7, the total waste composition by weight for the samples that were characterized is as follows:

- 39 percent rubber crumb and soil mixture;
- 26 percent decomposed MSW and soil mixture;
- 12 percent silty clay (typically located beneath the waste);
- 10 percent glass (broken bottles);
- 8 percent oily tar-like material; and
- 5 percent metal, soil, wood, pebbles/stones, and organics.

Based on the visual observations of the excavated waste material (presented in Section 4.1 of this document), the waste had a higher quantity of metal, wood and glass than indicated by the waste sample characterization results given above. This difference is attributed to the limitations of sorting a sample that is relatively small when compared to: (i) the quantity of material excavated from the test pit; and (ii) the size of the some of the pieces of waste that were excavated from the pits but, due to their size, not included in the sampling and sorting exercise. For example, several test pits had pieces of metal or plywood that were greater than 2 ft (0.6 m) square. A piece of waste this size would not be included in the waste characterization sample, but was considered when relative quantity estimates of the waste composition were made based on visual observations. Therefore, the waste sample characterization results are more applicable for describing the portion of the excavated waste that generally has a particle size less than 2 in. (50 mm) in its greatest dimension. General descriptions of the excavated waste are presented in Table 3. These description were based on: (i) visual observations of the excavated waste; (ii) visual observations of the bulk waste samples; and (iii) the waste characterization results.

Charts showing the percentages of the particle sizes for the rubber crumb and soil mixture, decomposed MSW and soil mixture, and glass are included in Figures 8 through 10 of this document. As shown on the charts, a majority of the sampled rubber crumb and soil mixture (51 percent) and the decomposed MSW and soil mixture (76 percent) had particles that passed the 1/4-in. (6.4 mm) sieve. In contrast, 43 percent of the glass particles were retained on the 1-in. (25.4 mm) sieve.

The results of the supplemental site investigation for the North Dike Area clearly indicate that a variety of municipal and industrial wastes were co-disposed in the area investigated. The results also indicate the presence of large items of debris within the waste matrix.

6. ORIGINAL REMEDY EVALUATION

6.1 Overview

GeoSyntec evaluated the solidification component of the original remedy in accordance with the screening process presented in "*Stabilization/Solidification of CERCLA and RCRA Wastes*" [EPA/625/6-89/022]. A literature review was also conducted and included a review of other USEPA guidance documents, the Federal Register, and various technical papers. The results of the evaluation are presented in this section of the document.

6.2 Results of Screening Process

The USEPA document, "*Stabilization/Solidification of CERCLA and RCRA Wastes*" [USEPA/625/6-89/022] provides a methodology that can be used to screen and evaluate solidification technologies. Section 6.1.1 of the document addresses the screening of wastes, and presents a flow chart (Figure 6-1) that indicates a number of decision points for the rejection of solidification. This flow chart is presented in Appendix C of this document. The first step in the process is to review "Major Waste Characteristics". This evaluation consists of answering questions regarding the characteristics and composition of the waste (responses for the North Dike Area waste are shown in parentheses). Step two evaluates engineering solutions. The process is outlined as follows:

- *Step 1 - Major Waste Characteristics:*
  - Significant amounts of oil/grease? (Yes, in many cases the waste was described as oily or tarry.)
  - Presence of wastes prohibited from landfilling? (Not evaluated in the supplemental site investigation.)
  - Waste not readily mixable (gummy/viscous)? (Yes, large quantities of gummy, viscous, rubbery, tar-like material.)
  - Significant amounts of highly volatile organic materials? (Yes, as evidenced by organic vapor readings, and previous waste analyses.)

  - Presence of certain types of debris? (Yes, significant quantities of debris (e.g., wood, metal, cable, glass, tires, drums).)

  - High water content in waste? (Yes, often described as saturated.)

- *Step 2 - Available Engineering Solutions:*
  - Oil/water separation? (Not viable)

  - Filtering/screening debris? (Could be viable in an ex-situ process, but would be difficult and expensive.)

  - Chemical/physical pretreatment? (May only be viable for localized areas (e.g., Pit B).)

  - Dewatering the waste? (Not viable).

Based on the above criteria, a solidification remedy should be rejected at this stage on the grounds of technical infeasibility.

6.3 Results of Literature Review

The literature review yielded the following results:

Presumptive Remedy for CERCLA Municipal Landfill Sites [USEPA 540-F-93-035]

In September 1993, USEPA issued this directive that establishes containment as an appropriate response action or presumptive remedy for CERCLA municipal landfills. The following language is taken from the directive:

"*Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat or where treatment is impracticable. The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents (55 FR 8704). Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial* *and/or hazardous waste. Because treatment usually is impracticable, USEPA generally considers containment to be the appropriate response action, or the "presumptive remedy," for the source areas of municipal landfill sites.*

The presumptive remedy for CERCLA municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected ground water at the perimeter of the landfill, and/or upgradient ground-water that is causing saturation of the landfill mass may be implemented as part of the presumptive remedy."

Components of a presumptive remedy for a municipal landfill may include one or more of the following:

- landfill cap;
- source area ground-water control to contain plume;
- leachate collection and treatment;
- landfill gas collection and treatment; and
- institutional controls to supplement engineering controls.

Only components from the above list that are necessary need be included as part of the remedy for a specific site. The data presented in this report demonstrates that both municipal and industrial wastes were co-disposed at the site. Therefore, the presumptive remedy presented above is applicable to the Bailey Superfund Site.

40 CFR, June 1, 1990, page 22568

This section of the Federal Register includes a discussion of treatment standards for lead wastes. In addressing this issue, it is evident that the Agency considers that organics interfere with the stabilization process particularly when the organic concentrations exceed 1 percent TOC. This conclusion was printed in 40 CFR stating, "*This is primarily because organics typically interfere with the conventional stabilization processes particularly at concentrations exceeding 1% TOC.*" Laboratory tests (loss on ignition) indicate that organic content of the North Marsh Area waste significantly exceeds 1% TOC.

Although significant developments have been made in the past several years with respect to the use of proprietary reagents, sorbents and organophilic clays, the data presented in this report indicates that other items such as large pieces of debris would likely be problematic, even if these reagents were used in areas containing high quantities of organic constituents.

7. SUMMARY OF FINDINGS

7.1 Overview

The findings presented in this section are the opinions of GeoSyntec and are based on: (i) a thorough review of previous studies and data; and (ii) the new data obtained during the supplemental site investigation activities.

7.2. North Dike Area Waste Composition

Based on a review of the previous data, the wastes at the Bailey site, particularly those present in the North Dike Area, were not sufficiently characterized to adequately evaluate the feasibility of solidification for the North Dike Area waste. Previous investigations did not adequately address the following:

- the waste composition at the micro-scale;
- the extent of large items of debris (macro-scale); and
- the organic content of the waste.

Based on the data gathered during the supplemental site investigation, the waste samples collected from the North Dike Area had an approximate gross composition (by weight) of: 39% rubber crumb and soil; 26% decomposed MSW and soil; 12% silty clay; 10% glass; 8% oily tar-like material; and 5% metal, soil, wood, pebbles, and organics. Visual observation of the test pit excavations indicated that the actual quantity of metal, wood, and glass is higher than represented by the bulk samples. This is attributed to sample sorting limitations and to difficulties in obtaining representative samples when the component sizes range from less than 1/4 in. (6.4 mm) to greater than 2 ft (0.6 m) square. Also, based on the results of loss on ignition tests performed on selected waste samples, the total organic content of the waste varied from 4% to 51%. This high organic content of the waste is further supported by waste descriptions, i.e., "oily," "very oily," or "tar-like," and by the presence of decomposed municipal waste.

Based on the results of the supplemental site investigation, a variety of municipal and industrial wastes were co-disposed in the area investigated. These wastes include a high proportion of large items of debris and have a high organic content.

7.3 Feasibility of Solidification of North Dike Area Wastes

Solidification was a required component of the original remedy. Based on an evaluation of the solidification component, GeoSyntec concludes that this component of the original remedy is technically infeasible and is not implementable for the majority of the North Dike Area wastes. The solidification component of the remedy was evaluated on the basis of various USEPA guidance documents, and with respect to accepted industry practice. An evaluation of the solidification component of the original remedy in accordance with the screening process presented in "*Stabilization/ Solidification of CERCLA and RCRA Wastes*" [EPA/625/6-89/022] yielded the following results:

- the major waste characteristics render the waste unacceptable for solidification without applying engineering solutions to remove problematic waste components; and
- potential engineering solutions to remove problematic waste components are generally not viable for the North Dike Area wastes.

Based on "*Presumptive Remedy for CERCLA Municipal Landfill Sites*" [EPA 540-F-93-035], USEPA recognizes the difficulties associated with the treatment of municipal wastes because of the size and heterogeneity of the waste components. Therefore, the presumptive remedy of containment was established for CERCLA municipal landfill sites. GeoSyntec considers this presumptive remedy to be applicable to the Bailey Site due to the presence of significant quantities of municipal waste and due to the documented variation in size and heterogeneity of the waste components.

Based on a review of information presented in 40 CFR, 1 June 1990, USEPA also recognizes that "*organics typically interfere with the conventional stabilization processes, particularly at concentrations exceeding 1% TOC.*" Analyses performed on selected waste samples indicate a total organic content (determined by loss on ignition) of 4% to 51% for the North Dike Area wastes. Therefore, solidification of the organic component in itself is problematic.

In their report on the in-situ pilot demonstration program for the East Dike Area, McLaren Hart and Kiber recommended a modification to the acceptance criteria for in-situ solidification. This would involve determining acceptance based on the collection of wet samples that would be cured and laboratory tested for permeability. Although this procedure may alleviate some problems associated with the solidification of certain areas of the East Dike Area, this change would not address the infeasibility of solidification in the North Dike Area, since this is related to the type, size, and heterogeneity of the waste components in that area.

Considering all of the data available on the North Dike Area, and the evaluation conducted on the solidification component of the original remedy, GeoSyntec concludes that solidification of the North Dike Area waste is technically infeasible.

7.4 Independent Professional Opinion on Supplemental Site Investigation Data

GeoSyntec retained Kiber to provide an independent professional opinion regarding the feasibility of stabilization/solidification of the North Dike Area wastes. The results of Kiber's evaluation are documented in their technical memorandum presented as Appendix D to this report. Kiber's conclusion states the following:

> *"In summary, Kiber feels that the original feasibility study lacked the detail and focus required to adequately assess the feasibility of stabilization and containment once identified as the preferred remedy. The supplemental site investigation performed by GeoSyntec clearly shows that the materials present in the North Dike Area are not amenable to effective stabilization treatment using either in situ or ex situ processes. In situ and ex situ stabilization treatment cannot be practically implemented given the large quantity of oversized wood, glass, metal fragments and rubber/tar. However, selective stabilization treatment is recommended for the portions of the Pit B area."*

8. CONCLUSIONS

Based on the additional data obtained during the supplemental site investigations, GeoSyntec's evaluation of the solidification component of the original remedy, and the findings presented in this report, GeoSyntec concludes the following:

- solidification of the entire North Dike Area is technically infeasible and should be eliminated from further consideration;
- solidification of certain "hot spots" or localized areas of the North Dike Area may be appropriate if is it evaluated to be necessary as a component of the revised remedy; the practice of isolating or providing special measures for "hot spot" areas is consistent with presumptive remedy directives for CERCLA municipal landfill sites; and
- if solidification is used as a component of a revised remedy for "hot spot" areas, the performance requirements should be evaluated and amended; new performance requirements should be developed that are both implementable and consistent with the engineering requirements of the revised remedy.

TABLES

TABLE 1
SUMMARY OF COLLECTED SAMPLES
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Test Pit	Sample Identification	Sample Type	Sample Depth (feet)
G-TP1	G-TP1-W-1	Waste	5.0
	G-TP1-W-2	Waste	7.5
G-TP2	G-TP2-W-1	Waste	5.5
	G-TP2-W-2	Waste	10.0
G-TP3	G-TP3-W-1	Waste	5.0
	G-TP3-W-2	Waste	7.0
G-TP4	G-TP4-W-1	Waste	4.0
	G-TP4-W-2	Waste	5.0
G-TP5	G-TP5-W-1	Waste	5.0
	G-TP5-W-2	Waste	10.0 to 11.0
	G-TP5-S-1	Soil beneath waste	11.0 to 12.0
G-TP6	G-TP6-W-1	Waste	5.0
	G-TP6-W-2	Waste	10.0
	G-TP6-W-2	Waste	11.0 to 12.0
G-TP7	G-TP7-W-1	Waste	5.0
	G-TP7-W-2	Waste	8.0
	G-TP7-S-1	Soil beneath waste	9.0
G-TP8	G-TP8-W-1	Waste	5.0
	G-TP8-W-2	Waste	6.0 to 7.0
	G-TP8-S-1	Soil beneath waste	7.0 to 8.0
G-TP9	G-TP9-W-1	Waste	0.0 to 4.0
G-TP10	G-TP10-W-1	Waste	4.0 to 5.0
G-TP11	G-TP11-W-1	Waste	4.0 to 5.0
	G-TP11-S-1	Soil beneath waste	5.0 to 6.0
G-TP12	G-TP12-W-1	Waste	5.5 to 6.0
	G-TP12-W-2	Waste	6.5
	G-TP12-S-1	Soil	7.0 to 8.0
G-TP13	G-TP13-W-1	Waste	5.0 to 6.0
	G-TP13-S-1	Soil beneath waste	8.5 to 9.0

TABLE 2
WASTE CHARACTERIZATION RESULTS
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Sample No.		G-TP1-W-1		G-TP1-W-2		G-TP2-W-1		G-TP2-W-2		G-TP3-W-1		G-TP3-W-2	
Sample Depth (feet)			5.0		7.5		5.5		10.0		5.0		7.0
Total Weight (lbs): bulk/sum of fractions		19.50	20.00	20.00	20.00	15.50	16.00	15.00	15.50	19.50	19.00	23.00	21.50
Total Volume (gal): bulk/ sum of fractions		2.25	2.27	1.67	1.67	2.50	2.58	2.25	2.72	2.50	2.33	2.50	2.50
Glass > 1"	Weight (lbs)	1.75											
1/2" < Glass < 1"	Weight (lbs)	0.75											
1/4" < Glass < 1/2"	Weight (lbs)	1.00											
Glass < 1/4"	Weight (lbs)	0.00											
Total Glass	Weight (lbs)	3.50	18%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.30	13%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Metal > 1"	Weight (lbs)	1.00											
1/2" < Metal < 1"	Weight (lbs)	0.00											
1/4" < Metal < 1/2"	Weight (lbs)	0.00											
Metal < 1/4"	Weight (lbs)	0.00											
Total Metal	Weight (lbs)	1.00	5%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.17	7%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
MSW/Soil > 1"	Weight (lbs)	1.00											
1/2" < MSW/Soil < 1"	Weight (lbs)	1.00											
1/4" < MSW/Soil < 1/2"	Weight (lbs)	1.00											
MSW/Soil < 1/4"	Weight (lbs)	11.00											
Total MSW/Soil	Weight (lbs)	14.00	70%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	1.60	71%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Rubber/Soil > 1"	Weight (lbs)					11.00		13.00		6.00		0.25	
1/2" < Rubber/Soil < 1"	Weight (lbs)					1.00		1.00		3.00		0.25	
1/4" < Rubber/Soil < 1/2"	Weight (lbs)					1.00		0.50		5.00		0.50	
Rubber/Soil < 1/4"	Weight (lbs)					3.00		1.00		5.00		20.50	
Total Rubber/Soil	Weight (lbs)	0.00	0%	0.00	0%	16.00	100%	15.50	100%	19.00	100%	21.50	100%
	Volume (gal)	0.00	0%	0.00	0%	2.58	100%	2.72	100%	2.33	100%	2.50	100%
Soil > 1"	Weight (lbs)	1.00											
1/2" < Soil < 1"	Weight (lbs)	0.00											
1/4" < Soil < 1/2"	Weight (lbs)	0.50											
Soil < 1/4"	Weight (lbs)	0.00											
Total Soil	Weight (lbs)	1.50	8%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.20	9%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Wood > 1"	Weight (lbs)												
1/2" < Wood < 1"	Weight (lbs)												
1/4" < Wood < 1/2"	Weight (lbs)												
Wood < 1/4"	Weight (lbs)												
Total Wood	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Plebbles/Stone > 1"	Weight (lbs)												
1/2" < Pebbles/Stone < 1"	Weight (lbs)												
1/4" < Pebbles/Stone < 1/2"	Weight (lbs)												
Pebbles/Stone < 1/4"	Weight (lbs)												
Total Pebbles/Stone	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Silty Clay	Weight (lbs)	0.00	0%	19.00	95%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
with some Tar/Oil	Volume (gal)	0.00	0%	1.34	80%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Organic (Straw)	Weight (lbs)	0.00	0%	1.00	5%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.33	20%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Viscous	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Viscous Very	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Notes:													

Samples sorted by BDJ and RND.
Data reduced by DBW.
Table checked by RND on 9/6/95 and 9/7/95.

GEOSYNTEC CONSULTANTS

TABLE 2 (Continued)
WASTE CHARACTERIZATION RESULTS
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Sample No.		G-TP4-W-1		G-TP4-W-2		G-TP5-W-1		G-TP5-W-2		G-TP6-W-1		G-TP6-W-2	
Sample Depth (feet)			4.0		5.0		5.0	10.0 to 11.0			5.0		10.0
Total Weight (lbs): bulk/sum of fractions		21.50	20.00	15.00	15.00	11.00	10.00	10.00	10.00	11.00	10.50	8.00	8.25
Total Volume (gal): bulk/ sum of fractions		2.50	1.37	0.75	0.75	1.13	1.00	0.88	1.15	0.88	0.67	0.75	0 83
Glass > 1"	Weight (lbs)	2.00				0.25		0.25		1.50		1.50	
1/2" < Glass < 1"	Weight (lbs)	1.00				1.75		0.00		1.00		0.50	
1/4" < Glass < 1/2"	Weight (lbs)	1.00				0.00		0.00		1.50		0.25	
Glass < 1/4"	Weight (lbs)	2.00				0.00		0.00		0.00		0.00	
Total Glass	Weight (lbs)	6.00	30%	0.00	0%	2.00	20%	0.25	3%	4.00	38%	2.25	27%
	Volume (gal)	0.50	37%	0.00	0%	0.13	13%	0.05	4%	0.33	50%	0 33	40%
Metal > 1"	Weight (lbs)												
1/2" < Metal < 1"	Weight (lbs)												
1/4" < Metal < 1/2"	Weight (lbs)												
Metal < 1/4"	Weight (lbs)												
Total Metal	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
MSW/Soil > 1"	Weight (lbs)							0.25		0.00			
1/2" < MSW/Soil < 1"	Weight (lbs)							0.00		0.00			
1/4" < MSW/Soil < 1/2"	Weight (lbs)							0.00		0.00			
MSW/Soil < 1/4"	Weight (lbs)							0.00		6.50			
Total MSW/Soil	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.25	3%	6.50	62%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.05	4%	0.33	50%	0.00	0%
Rubber/Soil > 1"	Weight (lbs)	1.00				1.00		0.25				0.50	
1/2" < Rubber/Soil < 1"	Weight (lbs)	0.00				0.75		0.25				0 50	
1/4" < Rubber/Soil < 1/2"	Weight (lbs)	3.00				0.50		0.00				1.00	
Rubber/Soil < 1/4"	Weight (lbs)	8.00				5.75		8.50				4.00	
Total Rubber/Soil	Weight (lbs)	12.00	60%	0.00	0%	8.00	80%	9.00	90%	0.00	0%	6.00	73%
	Volume (gal)	0.67	49%	0.00	0%	0.88	88%	1.00	87%	0.00	0%	0.50	60%
Soil > 1"	Weight (lbs)	0.00											
1/2" < Soil < 1"	Weight (lbs)	0.00											
1/4" < Soil < 1/2"	Weight (lbs)	0 00											
Soil < 1/4"	Weight (lbs)	2.00											
Total Soil	Weight (lbs)	2.00	10%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.20	15%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Wood > 1"	Weight (lbs)							0.25					
1/2" < Wood < 1"	Weight (lbs)							0.25					
1/4" < Wood < 1/2"	Weight (lbs)							0.00					
Wood < 1/4"	Weight (lbs)							0.00					
Total Wood	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.50	5%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.05	4%	0.00	0%	0.00	0%
Plebbles/Stone > 1"	Weight (lbs)												
1/2" < Pebbles/Stone < 1"	Weight (lbs)												
1/4" < Pebbles/Stone < 1/2"	Weight (lbs)												
Pebbles/Stone < 1/4"	Weight (lbs)												
Total Pebbles/Stone	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Silty Clay	Weight (lbs)	0.00	0%	15.00	100%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
with some Tar/Oil	Volume (gal)	0.00	0%	0.75	100%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Organic (Straw)	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Viscous	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Viscous Very	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Notes:													

Samples sorted by BDJ and RND.
Data reduced by DBW.
Table checked by RND on 9/6/95 and 9/7/95.

GeoSyntec Consultants

TABLE 2 (Continued)
WASTE CHARACTERIZATION RESULTS
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Sample No.		G-TP6-W-3		G-TP7-W-1		G-TP7-W-2		G-TP8-W-1		G-TP8-W-2		G-TP9-W-1	
Sample Depth (feet)		11.5 to 12.0			5.0		8.0		5.0	6.0 to 7.0		0.0 to 4.0	
Total Weight (lbs): bulk/sum of fractions		13.00	13.00	11.00	10.75	12.00	10.75	13.00	11.25	11.00	12.00	13.00	13 00
Total Volume (gal): bulk/ sum of fractions		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.05	0.88	0.80	1.25	1.25
Glass > 1"	Weight (lbs)			1.50				0.50		1.00			
1/2" < Glass < 1"	Weight (lbs)			1.00				1.00		0.50			
1/4" < Glass < 1/2"	Weight (lbs)			0.50				0.50		0.50			
Glass < 1/4"	Weight (lbs)			0.00				0.00		0.00			
Total Glass	Weight (lbs)	0.00	0%	3.00	28%	0.00	0%	2.00	18%	2.00	17%	0.00	0%
	Volume (gal)	0.00	0%	0.25	25%	0.00	0%	0.13	12%	0.20	25%	0.00	0%
Metal > 1"	Weight (lbs)	6 inch piece		0.50				0.25		1.00			
1/2" < Metal < 1"	Weight (lbs)	(separated from		0.00				0.00		0.00			
1/4" < Metal < 1/2"	Weight (lbs)	the sample)		0.25				0.00		0.00			
Metal < 1/4"	Weight (lbs)			0.00				0.00		0.00			
Total Metal	Weight (lbs)	0.00	0%	0.75	7%	0.00	0%	0.25	2%	1.00	8%	0.00	0%
	Volume (gal)	0.00	0%	0.13	13%	0.00	0%	0.05	5%	0.10	13%	0.00	0%
MSW/Soil > 1"	Weight (lbs)	0.00		0.00		2.25		2.00		1.00			
1/2" < MSW/Soil < 1"	Weight (lbs)	0.00		0.00		1.25		1.00		1.00			
1/4" < MSW/Soil < 1/2"	Weight (lbs)	0.00		0.00		0.00		1.00		0.50			
MSW/Soil < 1/4"	Weight (lbs)	13.00		3.00		5.00		4.00		6.50			
Total MSW/Soil	Weight (lbs)	13.00	100%	3.00	28%	8.50	79%	8.00	71%	9.00	75%	0.00	0%
	Volume (gal)	1.00	100%	0.25	25%	0.75	75%	0.75	71%	0.50	63%	0.00	0%
Rubber/Soil > 1"	Weight (lbs)			1.00									
1/2" < Rubber/Soil < 1"	Weight (lbs)			0.25									
1/4" < Rubber/Soil < 1/2"	Weight (lbs)			0.75									
Rubber/Soil < 1/4"	Weight (lbs)			0.00									
Total Rubber/Soil	Weight (lbs)	0.00	0%	2.00	19%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.25	25%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Soil > 1"	Weight (lbs)												
1/2" < Soil < 1"	Weight (lbs)												
1/4" < Soil < 1/2"	Weight (lbs)												
Soil < 1/4"	Weight (lbs)												
Total Soil	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Wood > 1"	Weight (lbs)	1 inch piece											
1/2" < Wood < 1"	Weight (lbs)	(separated from											
1/4" < Wood < 1/2"	Weight (lbs)	the sample)											
Wood < 1/4"	Weight (lbs)												
Total Wood	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Plebbles/Stone > 1"	Weight (lbs)			1.50		0.00		1.00					
1/2" < Pebbles/Stone < 1"	Weight (lbs)			0.00		0.00		0.00					
1/4" < Pebbles/Stone < 1/2"	Weight (lbs)			0.50		2.25		0.00					
Pebbles/Stone < 1/4"	Weight (lbs)			0.00		0.00		0.00					
Total Pebbles/Stone	Weight (lbs)	0.00	0%	2.00	19%	2.25	21%	1.00	9%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.13	13%	0.25	25%	0.13	12%	0.00	0%	0.00	0%
Gray to Black Silty Clay	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
with some Tar/Oil	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Organic (Straw)	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Gray to Black Viscous	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	13.00	100%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	1.25	100%
Gray to Black Viscous Very	Weight (lbs)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%	0.00	0%
Notes:													

Samples sorted by BDJ and RND.
Data reduced by DBW.
Table checked by RND on 9/6/95 and 9/7/95.

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TABLE 2 (Continued)
WASTE CHARACTERIZATION RESULTS
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

Sample No.		G-TP10-W-1		G-TP11-W-1		TOTAL WEIGHT		PERCENT
Sample Depth (feet)		4.0 to 5.0		4.0 to 5.0		Bulk	Sum	OF TOTAL
Total Weight (lbs): bulk/sum of fractions		9.00	9.00	12.00	11.25	283.00	276.75	100%
Total Volume (gal): bulk/ sum of fractions		0.75	0.75	0.88	0.85	28.30	27.54	100%
Glass > 1"	Weight (lbs)	1.00		0.25			11.50	
1/2" < Glass < 1"	Weight (lbs)	0.00		0.50			8.00	
1/4" < Glass < 1/2"	Weight (lbs)	0.00		0.00			5.25	
Glass < 1/4"	Weight (lbs)	0.00		0.00			2.00	
Total Glass	Weight (lbs)	1.00	11%	0.75	7%		26.75	10%
	Volume (gal)	0.13	17%	0.10	12%		2.44	9%
Metal > 1"	Weight (lbs)						2.75	
1/2" < Metal < 1"	Weight (lbs)						0.00	
1/4" < Metal < 1/2"	Weight (lbs)						0.25	
Metal < 1/4"	Weight (lbs)						0.00	
Total Metal	Weight (lbs)	0.00	0%	0.00	0%		3.00	1%
	Volume (gal)	0.00	0%	0.00	0%		0.44	2%
MSW/Soil > 1"	Weight (lbs)			2.00			8.50	
1/2" < MSW/Soil < 1"	Weight (lbs)			1.00			5.25	
1/4" < MSW/Soil < 1/2"	Weight (lbs)			1.50			4.00	
MSW/Soil < 1/4"	Weight (lbs)			6.00			55.00	
Total MSW/Soil	Weight (lbs)	0.00	0%	10.50	93%		72.75	26%
	Volume (gal)	0.00	0%	0.75	88%		5.98	22%
Rubber/Soil > 1"	Weight (lbs)						34.00	
1/2" < Rubber/Soil < 1"	Weight (lbs)						7.00	
1/4" < Rubber/Soil < 1/2"	Weight (lbs)						12.25	
Rubber/Soil < 1/4"	Weight (lbs)						55.75	
Total Rubber/Soil	Weight (lbs)	0.00	0%	0.00	0%		109.00	39%
	Volume (gal)	0.00	0%	0.00	0%		13.43	49%
Soil > 1"	Weight (lbs)						1.00	
1/2" < Soil < 1"	Weight (lbs)						0.00	
1/4" < Soil < 1/2"	Weight (lbs)						0.50	
Soil < 1/4"	Weight (lbs)						2.00	
Total Soil	Weight (lbs)	0.00	0%	0.00	0%		3.50	1%
	Volume (gal)	0.00	0%	0.00	0%		0.40	1%
Wood > 1"	Weight (lbs)						0.25	
1/2" < Wood < 1"	Weight (lbs)						0.25	
1/4" < Wood < 1/2"	Weight (lbs)						0.00	
Wood < 1/4"	Weight (lbs)						0.00	
Total Wood	Weight (lbs)	0.00	0%	0.00	0%		0.50	0%
	Volume (gal)	0.00	0%	0.00	0%		0.05	0%
Plebbles/Stone > 1"	Weight (lbs)						2.50	
1/2" < Pebbles/Stone < 1"	Weight (lbs)						0.00	
1/4" < Pebbles/Stone < 1/2"	Weight (lbs)						2.75	
Pebbles/Stone < 1/4"	Weight (lbs)						0.00	
Total Pebbles/Stone	Weight (lbs)	0.00	0%	0.00	0%		5.25	2%
	Volume (gal)	0.00	0%	0.00	0%		0.50	2%
Gray to Black Silty Clay	Weight (lbs)	0.00	0%	0.00	0%		34.00	12%
with some Tar/Oil	Volume (gal)	0.00	0%	0.00	0%		2.09	8%
Organic (Straw)	Weight (lbs)	0.00	0%	0.00	0%		1.00	0%
	Volume (gal)	0.00	0%	0.00	0%		0.33	1%
Gray to Black Viscous	Weight (lbs)	0.00	0%	0.00	0%		13.00	5%
Oily Tar-like Material	Volume (gal)	0.00	0%	0.00	0%		1.25	5%
Gray to Black Viscous Very	Weight (lbs)	8.00	89%	0.00	0%		8.00	3%
Oily Tar-like Material	Volume (gal)	0.63	83%	0.00	0%		0.63	2%
Notes:		2 animal bones						
		in bulk sample						

Samples sorted by BDJ and RND.
Data reduced by DBW.
Table checked by RND on 9/6/95 and 9/7/95.

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TABLE 3
GENERAL DESCRIPTIONS OF EXCAVATED WASTE
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

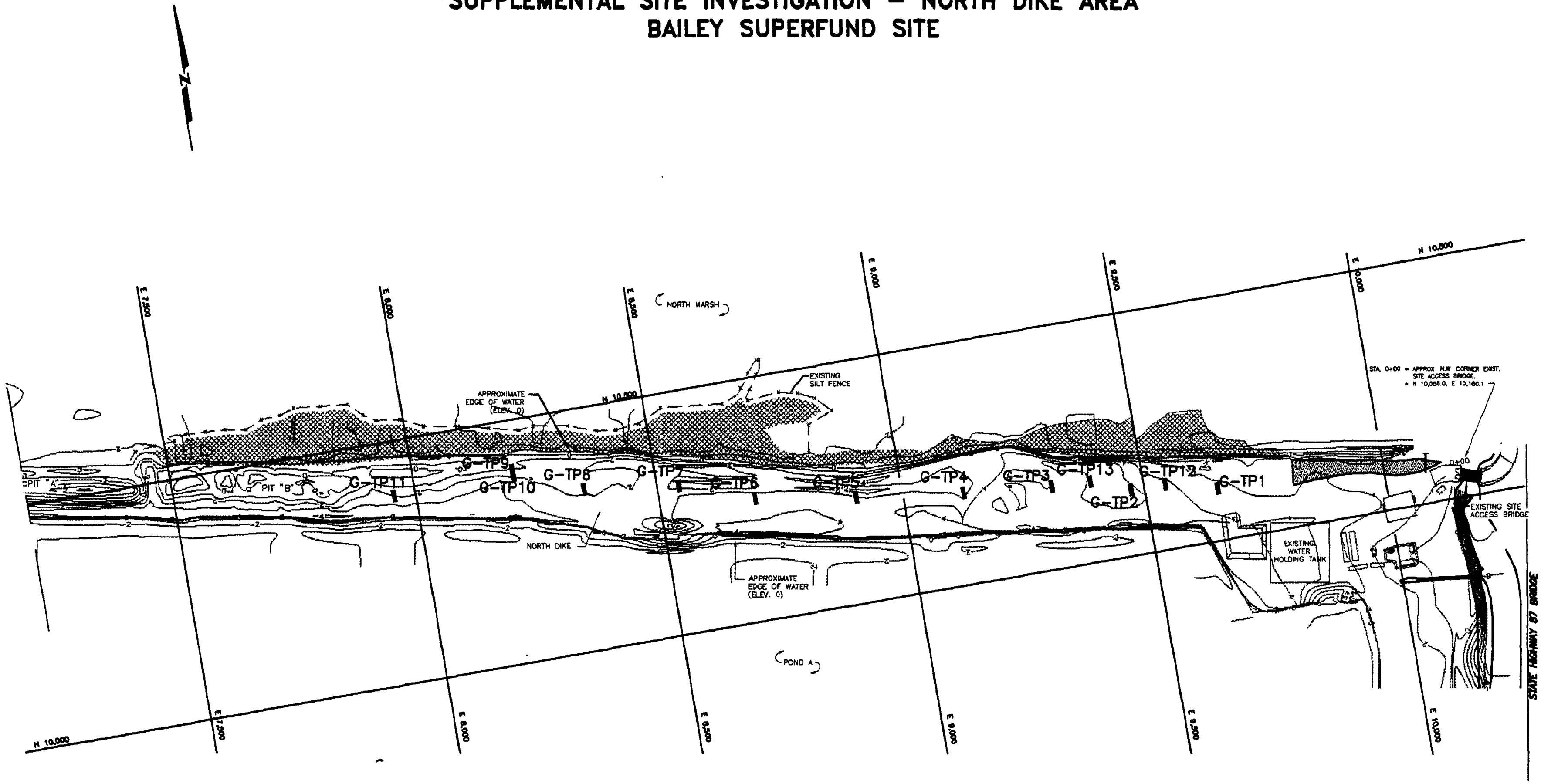
Test Pit	General Decription (1)	Comments
G-TP1	MSW and Soil Mixture with Rubber Crumb and Rubbery Waste	Quantity of rubber wastes increased as depth increased
G-TP2	Rubber Crumb and Soil Mixture with Rubbery Waste	
G-TP3	Rubber Crumb and Soil Mixture	
G-TP4	Rubber Crumb and Soil Mixture with MSW	MSW: metal, paper, glass, wood, 2 tires
G-TP5	Rubber Crumb and Soil Mixture with MSW and Rubbery Waste	MSW: metal, glass, tire, 55-gallon drum
G-TP6	Rubber Crumb and Soil Mixture with MSW	MSW: metal, glass, wood, large metal pieces
G-TP7	MSW and Soil Mixture with Rubber Crumb	MSW: metal, glass, wood, water heater, 55-gallon drum, metal pipes, large metal pieces, plywood
G-TP8	MSW and Soil Mixture	MSW: metal, glass, wood, large metal pieces, wire, metal pipe
G-TP9	Oily Tar-like Material with MSW	MSW: metal pipe, unbroken glass bottles, plywood
G-TP10	Very Oily Tar-like Material with MSW	MSW: metal, unbroken glass bottles, metal pipe
G-TP11	MSW and Soil Mixture with Rubber Crumb	MSW: metal, glass, wood, metal pipe, wire, large metal pieces
G-TP12	MSW and Soil Mixture with Rubber Crumb	MSW: metal, glass, wood; quantity rubber crumb increased as depth increased
G-TP13	MSW and Soil Mixture with Rubber Crumb	Quantity of rubber crumb increased as depth increased

Notes:

1. Description based on visual observations of excavated waste, visual observations of bulk waste samples, and the waste characterization results.

FIGURES

TEST PIT LOCATIONS
SUPPLEMENTAL SITE INVESTIGATION – NORTH DIKE AREA
BAILEY SUPERFUND SITE



LEGEND

▮G–TP6 DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT

NORTH MARSH WASTE

NOTES:

BASE MAP PREPARED BY HARDING LAWSON ASSOCIATES, HOUSTON, TEXAS.

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ATLANTA, GA

PROJECT NO.	GA3913-04	FIGURE NO.	FIGURE 1
DOCUMENT NO.	GA951149	FILE NO.	3913-001

FIGURE 2
SAMPLE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

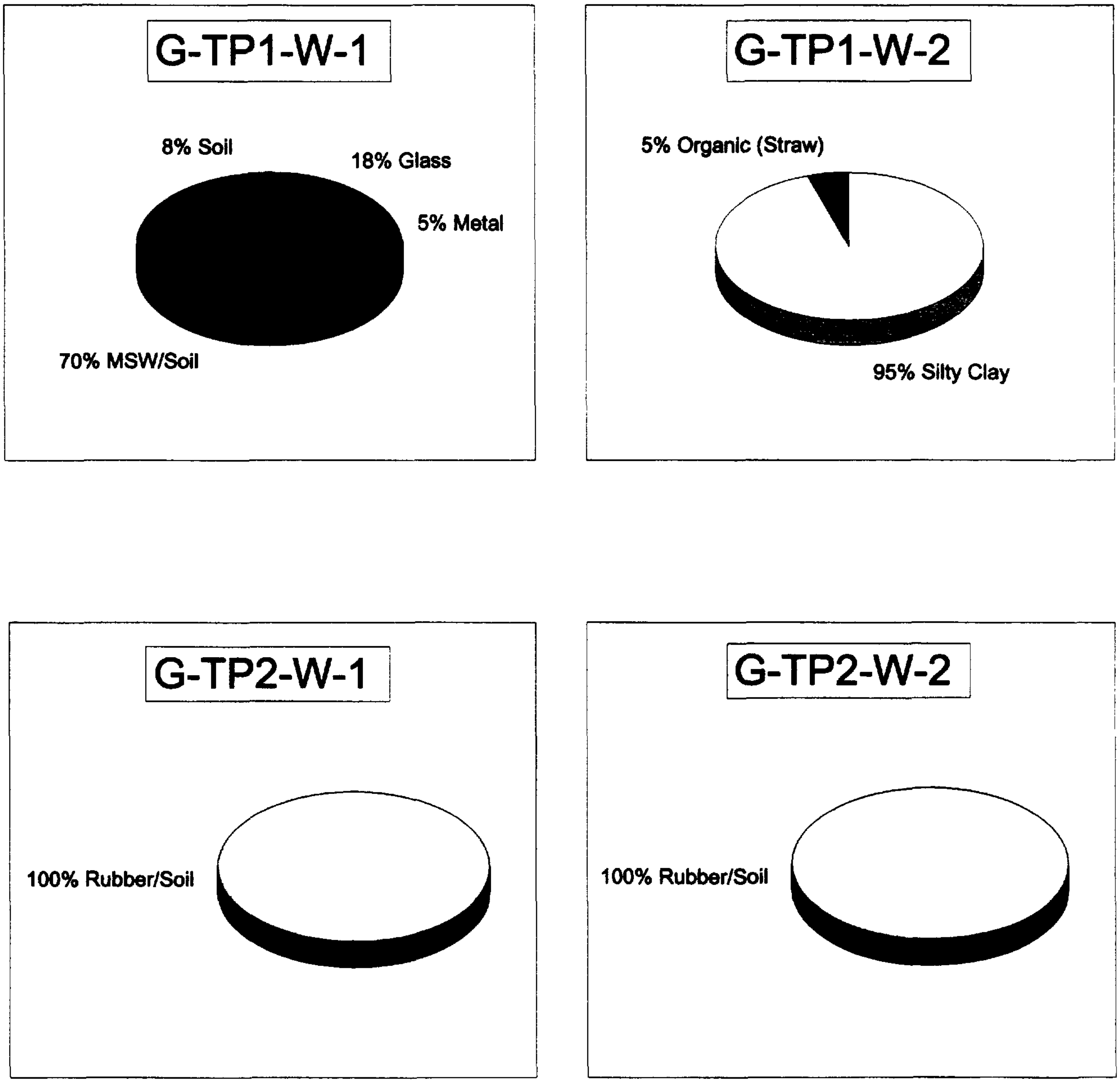

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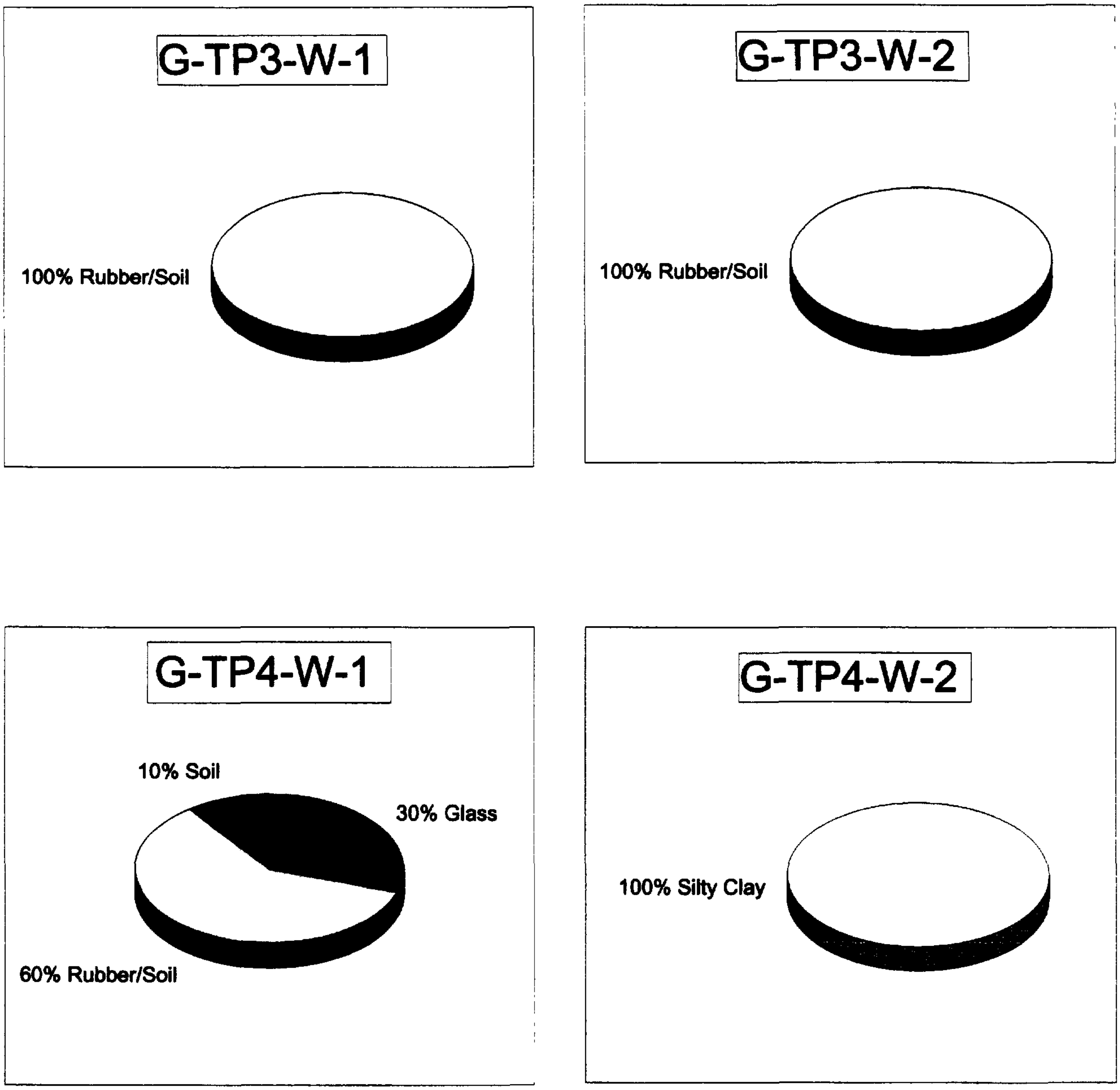
FIGURE 3
SAMPLE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE



GeoSyntec Consultants

FIGURE 4
SAMPLE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

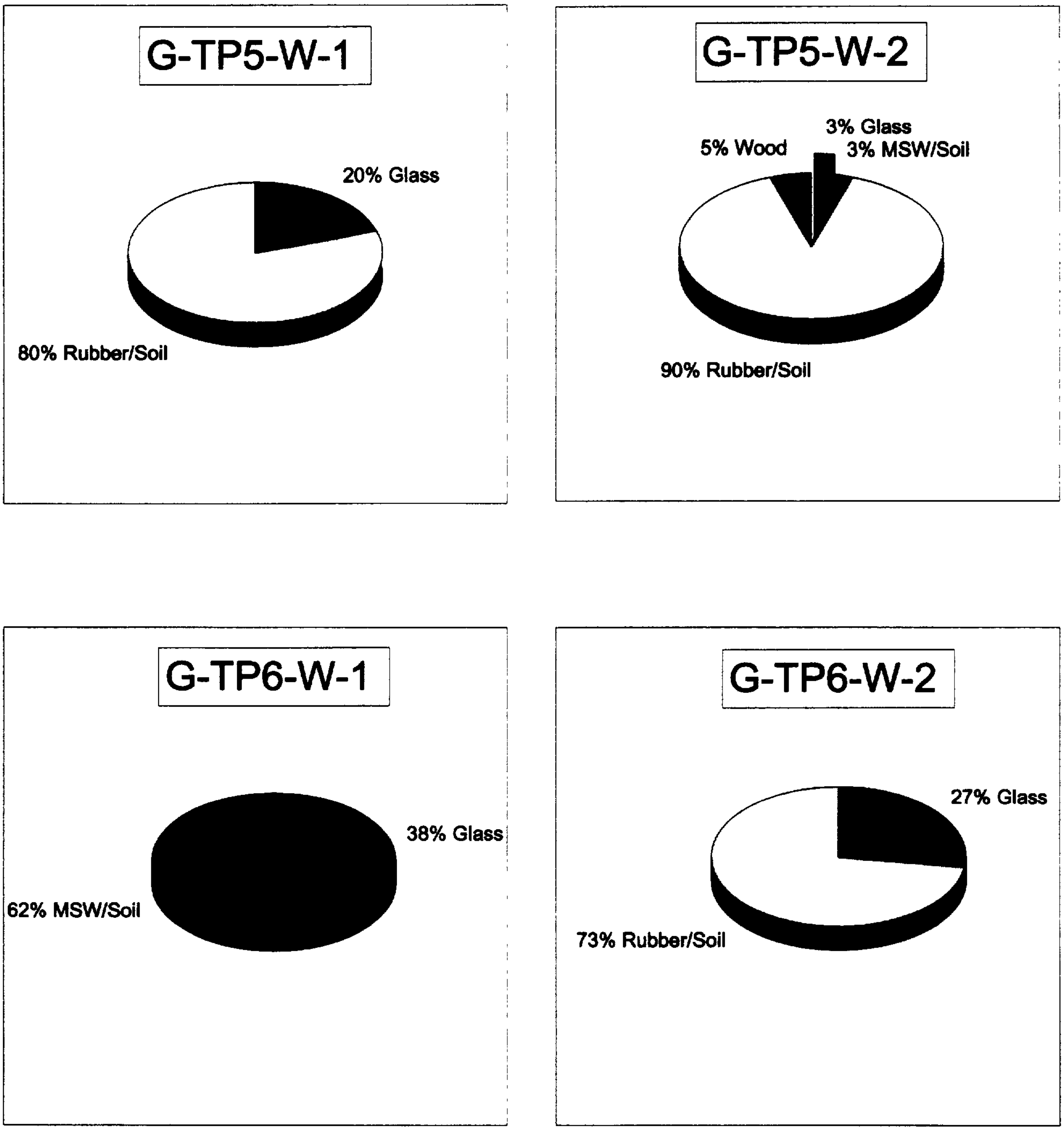


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FIGURE 5
SAMPLE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

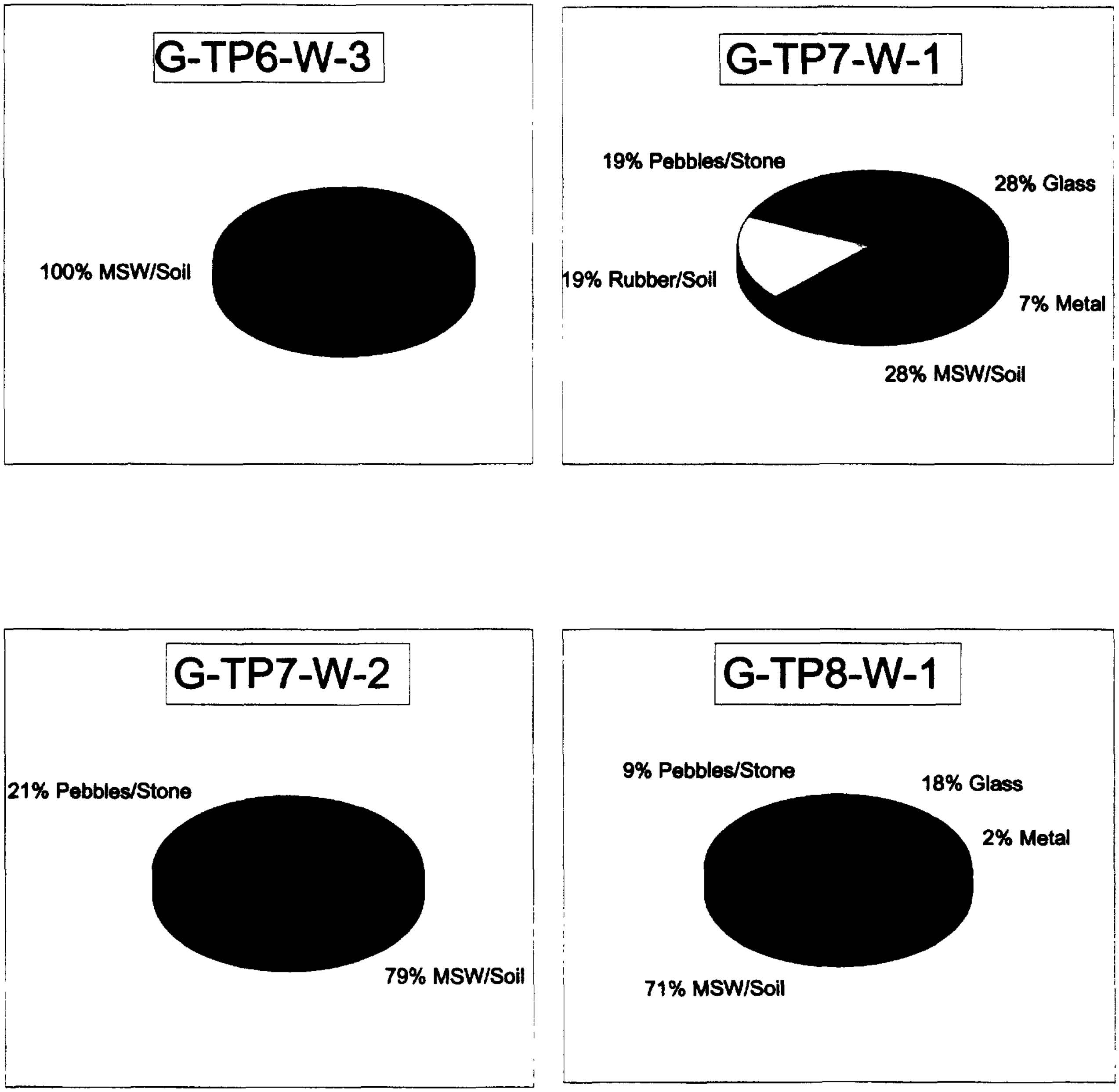

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FIGURE 6
SAMPLE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE

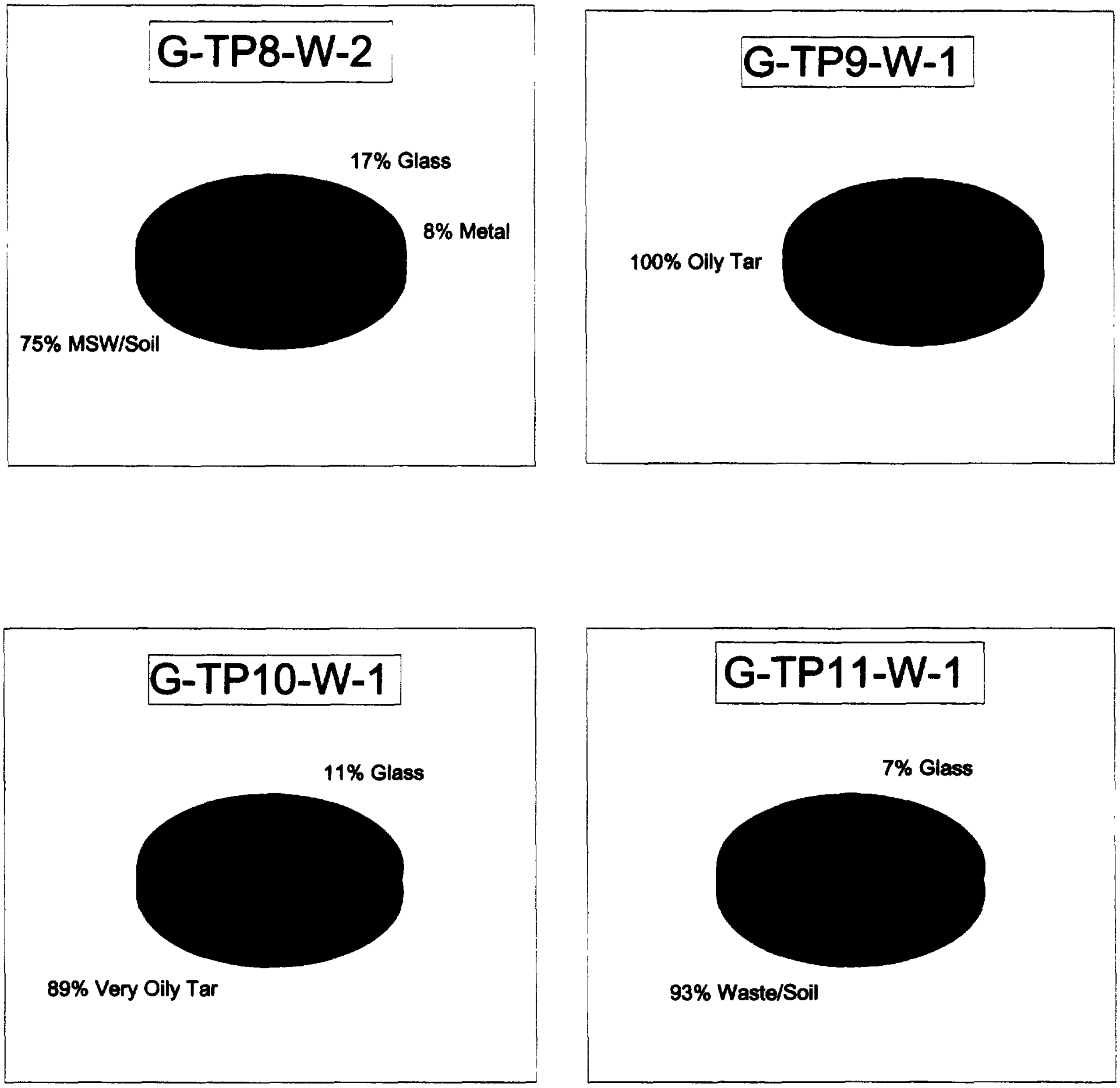

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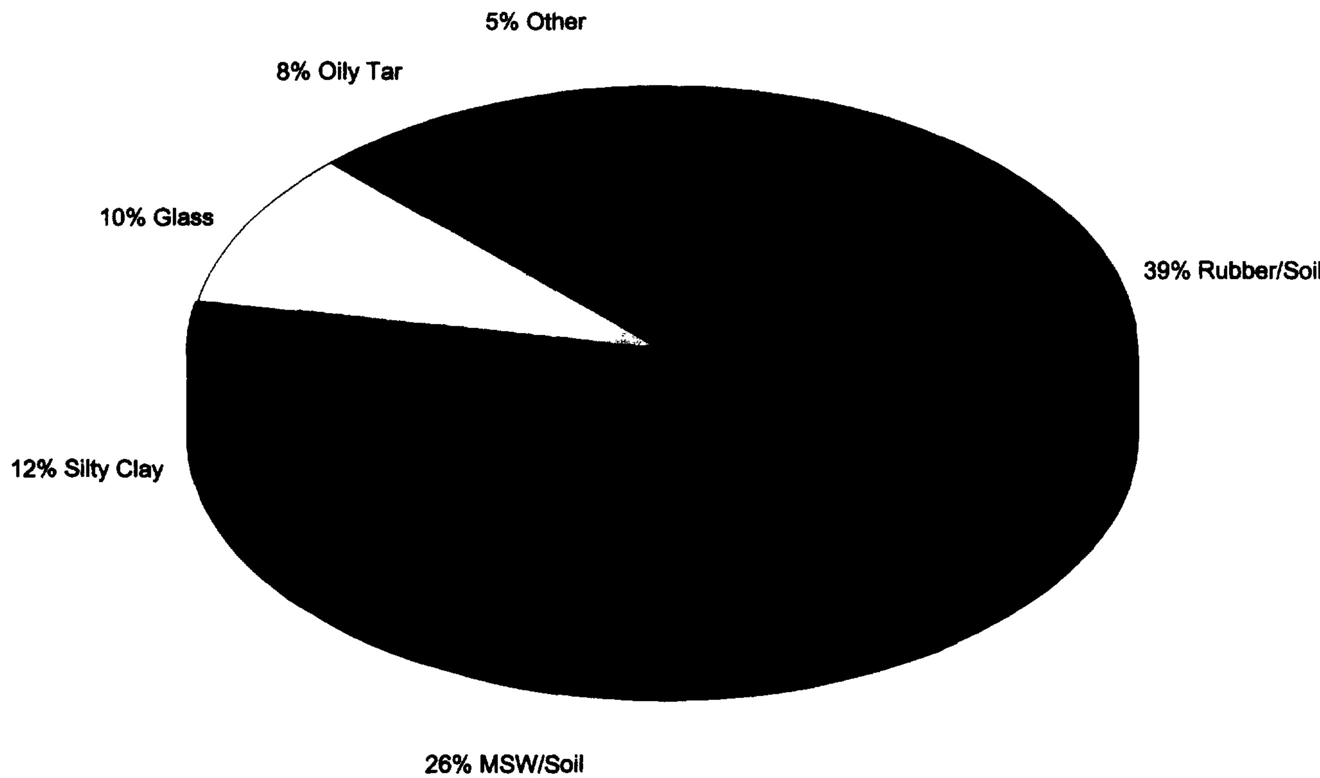
FIGURE 7
TOTAL WASTE COMPOSITION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE



COMPOSITION OF "OTHER"

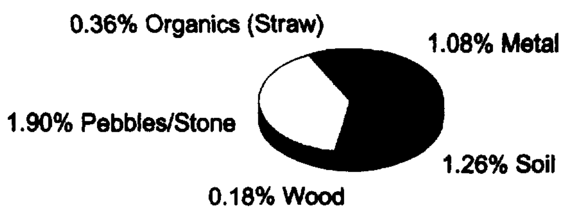


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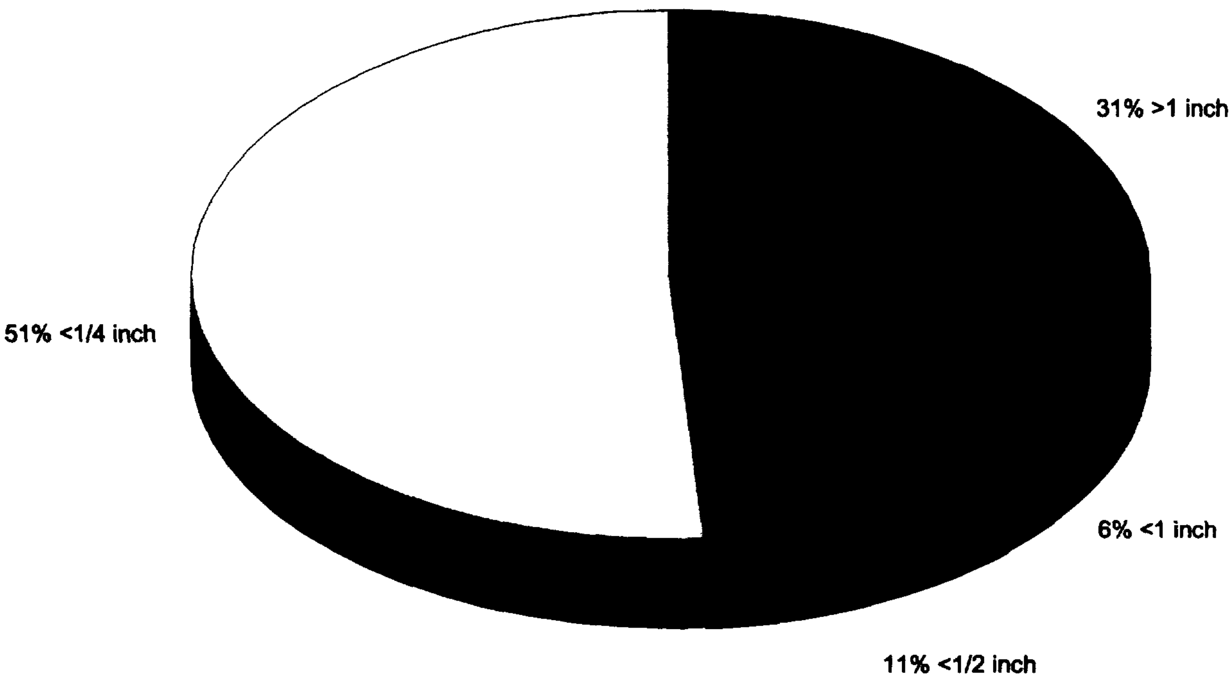
FIGURE 8
RUBBER CRUMB/SOIL GRADATION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE



Notes:
1. Rubber/Soil was observed in 9 of the 20 test pit samples.

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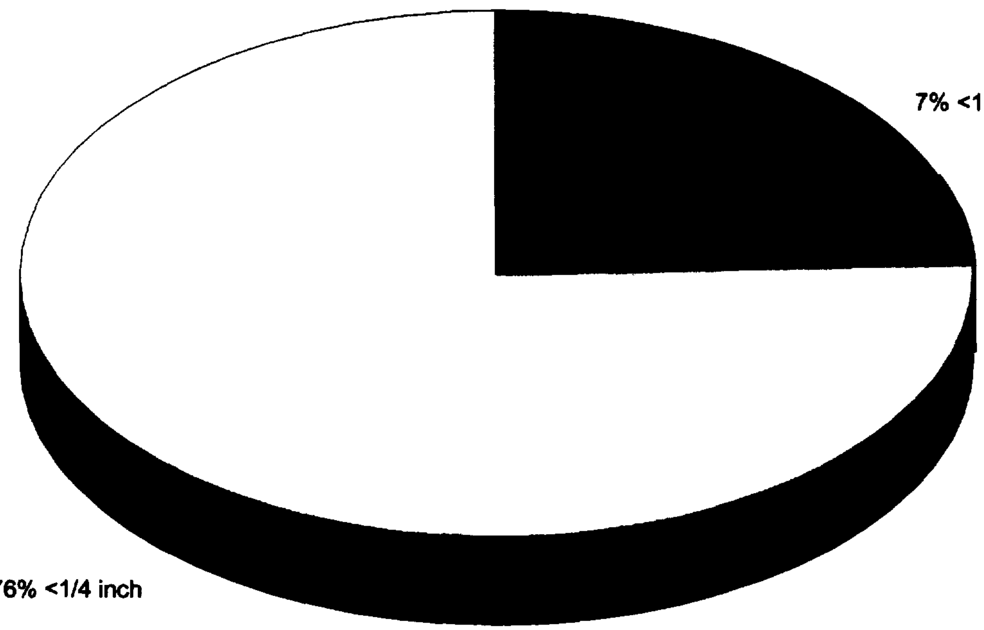
FIGURE 9
MUNICIPAL SOLID WASTE/SOIL GRADATION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE



Notes:

1. Municipal Soilid Waste/Soil was observed in 9 of the 20 test pit samples.

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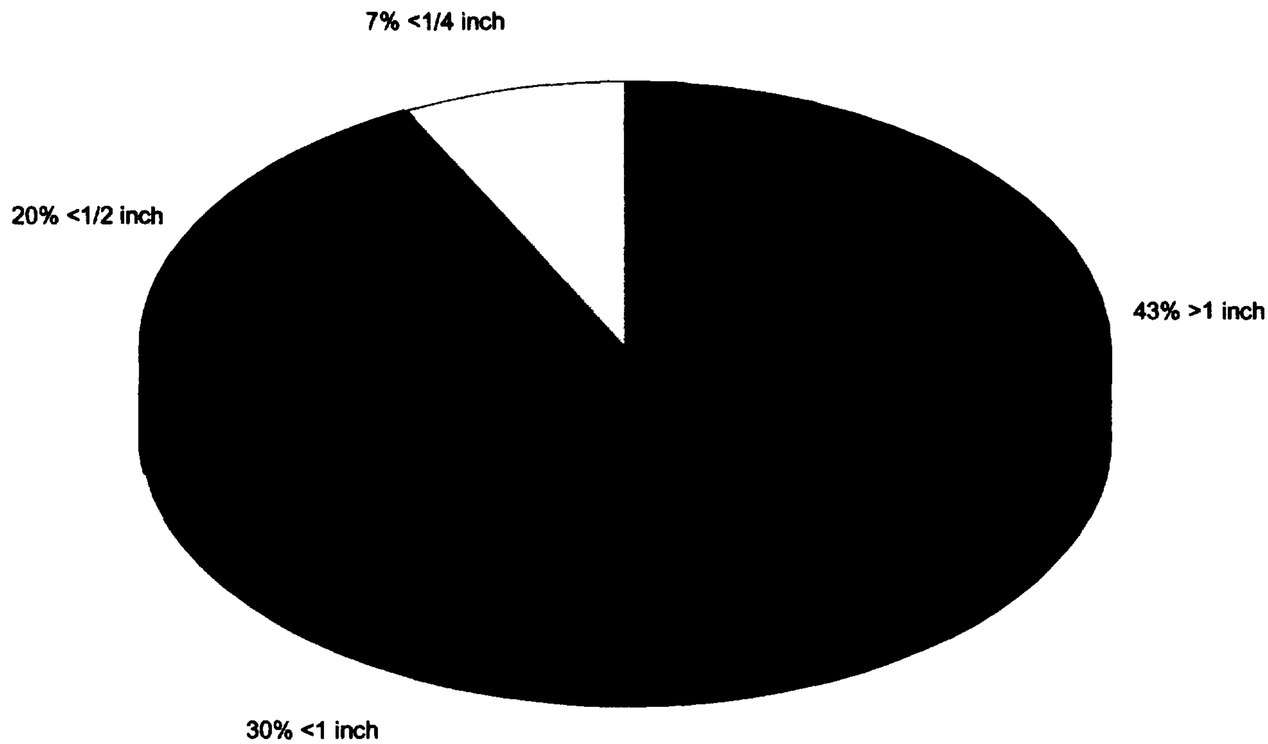
FIGURE 10
GLASS GRADATION BY WEIGHT
NORTH DIKE INVESTIGATION
BAILEY SUPERFUND SITE



Notes:
1. Glass was observed in 11 of the 20 test pit samples.

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APPENDIX A

TEST PIT OBSERVATIONS AND PHOTOGRAPHS

G-TP1

Date:	22 August 1995
Overburden Thickness (feet):	0.5 to 2.5
Depth to Bottom of Waste (feet):	7.5 to 8.5
Depth to Ground Water (feet):	3.7
Description of Soil Beneath Waste:	Gray silty CLAY with black stains and fine roots
Bottom of Test Pit (feet):	10.0
Samples (Depth (feet)):	G-TP1-W-1 (5.0) G-TP1-W-2 (7.5)

Test Pit Description:

The upper portion of waste (to a depth of approximately 5.0 feet) was light to dark brown in color and primarily a mixture of municipal solid waste and soil. This mixture included metal (5 to 10 percent), glass (5 to 10 percent), large roots and lumber (5 to 10 percent), and soil and decomposed waste (60 to 70 percent).

From an approximate depth of 5.0 feet to the bottom of the waste (7.5 to 8.5 feet), the waste was black in color and had an oily sheen. The waste was a mixture of metal (5 to 10 percent); glass (5 to 10 percent); rubbery waste (5 to 10 percent); and decomposed waste, rubber crumb and soil (60 to 70 percent).

Sample Description (G-TP1-W1):

Black oily MUNICIPAL SOLID WASTE AND SOIL MIXTURE with glass and some ferrous metal. The sample had a high liquid content (oily water). Sample headspace reading was 0-20 ppm total volatile organic compounds (VOCs).

Sample Description (G-TP1-W2):

Black silty CLAY with heavy oil/tar contamination. Sample also contained some organic material (straw and fine roots). Sample headspace reading was 0-20 ppm total VOCs.

G-TP2

Date:	22 August 1995
Overburden Thickness (feet):	2.0 to 3.0
Depth to Bottom of Waste (feet):	10.5 to 11.0
Depth to Ground Water (feet):	12.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	12.0
Samples (Depth (feet)):	G-TP2-W-1 (5.5) G-TP2-W-2 (10.0)

Test Pit Description:

The waste was dark brown to black in color and was primarily comprised of soil, rubber crumb, and pieces of rubbery waste. The rubbery waste had a very elastic consistency (similar to soft rubber) that could be pulled like taffy. Relatively small amounts (less than 5 percent) of glass and metal were observed in the waste mixture. A light brown soil/waste layer was encountered in the lower portion of the test pit.

Sample Description (G-TP2-W1):

Black oily RUBBER CRUMB AND SOIL MIXTURE. Sample headspace reading was not taken.

Sample Description (G-TP2-W2):

Black oily RUBBER CRUMB AND SOIL MIXTURE. Sample headspace reading was not taken.

G-TP3

Date:	22 August 1995
Overburden Thickness (feet):	1.0
Depth to Bottom of Waste (feet):	8.0
Depth to Ground Water (feet):	Not encountered
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	10.0
Samples (Depth (feet)):	G-TP3-W-1 (5.0) G-TP3-W-2 (7.0)

Test Pit Description:

The waste was dark brown to black in color and was comprised of soil and rubber crumb.

Sample Description (G-TP3-W1):

Black oily RUBBER CRUMB AND SOIL MIXTURE. Sample headspace reading was 80 ppm total VOCs.

Sample Description (G-TP3-W2):

Black oily RUBBER CRUMB AND SOIL MIXTURE. Sample headspace reading was 20 ppm total VOCs.

G-TP4

Date:	22 August 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	5.0
Depth to Ground Water (feet):	4.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	7.5
Samples (Depth (feet)):	G-TP4-W-1 (4.0) G-TP4-W-2 (5.0)

Test Pit Description:

The waste was black in color and had an oily sheen. The waste was a mixture of metal (5 to 10 percent); paper (5 to 10 percent); glass (5 to 10 percent); lumber and large roots (5 to 10 percent); decomposed waste, rubber crumb and soil (60 to 80 percent). The waste material also contained two automobile tires.

Sample Description (G-TP4-W1):

Black oily RUBBER CRUMB AND SOIL MIXTURE with glass. Sample also contained some clay and a small quantity of organic material (straw and fine roots). Sample headspace reading was 10-15 ppm total VOCs.

Sample Description (G-TP4-W2):

Gray silty CLAY with some black oily (free product) contamination. Sample headspace reading was 0 ppm total VOCs.

G-TP5

Date:	23 August 1995
Overburden Thickness (feet):	0.0 to 0.5
Depth to Bottom of Waste (feet):	10.0 to 11.0
Depth to Ground Water (feet):	3.0 to 4.0
Description of Soil Beneath Waste:	Light brown sandy SILT with clay and black stains
Bottom of Test Pit (feet):	12.0
Samples (Depth (feet)):	G-TP5-W-1 (5.0)
	G-TP5-W-2 (10.0 to 11.0)
	G-TP5-S-1 (11.0 to 12.0)
Waste Temperature:	G-TP5-W-1: 78 degrees Fahrenheit

Test Pit Description:

The upper portion of waste (to a depth of approximately 3.0 feet) was light to dark brown in color and primarily a mixture of municipal solid waste and soil. This mixture included metal (5 to 10 percent), glass (5 to 10 percent), and soil and decomposed waste (80 to 90 percent). The upper portion of the waste also included several automobile tires and a 55-gallon drum.

From an approximate depth of 3.0 feet to the bottom of the waste (10.0 to 11.0 feet), the waste was black in color and had an oily sheen. The waste was a mixture of metal (5 to 10 percent); glass (5 to 10 percent); paper (less than 5 percent); wood waste (less than 5 percent); rubbery waste (5 to 10 percent); and decomposed waste, rubber crumb and soil (60 to 70 percent).

Sample Description (G-TP5-W1):

Black oily RUBBER CRUMB AND SOIL MIXTURE. Sample also contained some glass and some small pieces of municipal waste (not discernible from rubber crumb). Sample headspace reading was 5-10 ppm total VOCs.

Sample Description (G-TP5-W2):

This sample appeared to have been taken at the soil/waste interface, as the sample was readily split into soil and waste fractions. The soil was gray silty CLAY. Only the waste fraction was hand-sorted. The waste was a black very tarry RUBBER CRUMB AND SOIL MIXTURE with fragments of wood and glass. Sample headspace reading was 50 ppm total VOCs.

G-TP6

Date:	23 August 1995
Overburden Thickness (feet):	0.5 to 1.5
Depth to Bottom of Waste (feet):	12.0
Depth to Ground Water (feet):	5.0 to 6.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	13.0
Samples (Depth (feet)):	G-TP6-W-1 (5.0) G-TP6-W-2 (10.0) G-TP6-W-3 (11.5 to 12.0)
Waste Temperature:	G-TP6-W-2: 78 degrees Fahrenheit

Test Pit Description:

The waste was black in color and had an oily sheen. The waste was a mixture of metal (10 to 20 percent); glass (10 to 20 percent); wood waste (5 to 10 percent); and decomposed waste, rubber crumb and soil (60 to 70 percent). The metal portion of the waste was comprised of relatively large pieces (2 square feet and greater) and metal pipe (1 to 2 inches in diameter). The wood portion of the waste was observed in the lower portions of the test pit.

Sample Description (G-TP6-W1):

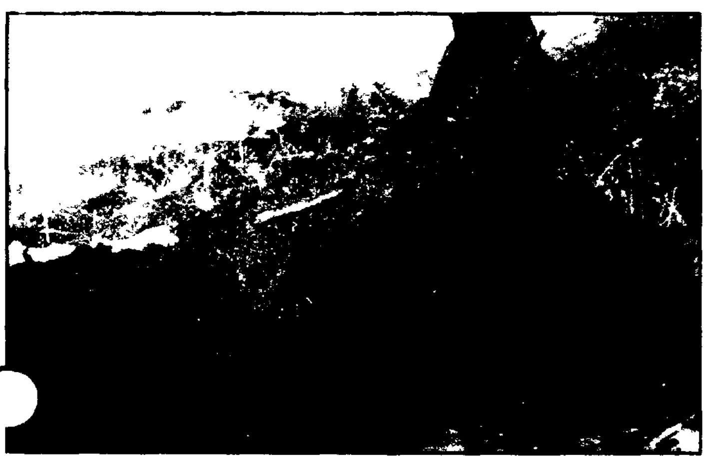
Black very oily MUNICIPAL SOLID WASTE, RUBBER CRUMB, AND SOIL MIXTURE (could not be separated) with glass. Sample also contained some oily "free product". Sample headspace reading was 60 ppm total VOCs.

Sample Description (G-TP6-W2):

Black oily RUBBER CRUMB AND SOIL MIXTURE with some glass. Sample headspace reading was 40-50 ppm total VOCs.

Sample Description (G-TP6-W3):

Black very oily MUNICIPAL SOLID WASTE AND SOIL MIXTURE with some debris (metal strap, wood, wire, and a circuit breaker). Sample also contained some oily "free product". Sample had a very sticky fluid-like consistency. Sample headspace reading was not taken.



G-TP7

Date:	23 August 1995
Overburden Thickness (feet):	1.0 to 1.5
Depth to Bottom of Waste (feet):	8.0 to 9.0
Depth to Ground Water (feet):	4.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains and fine roots
Bottom of Test Pit (feet):	11.0
Samples (Depth (feet)):	G-TP7-W-1 (5.0) G-TP7-W-2 (8.0) G-TP7-S-1 (9.0)

Test Pit Description:

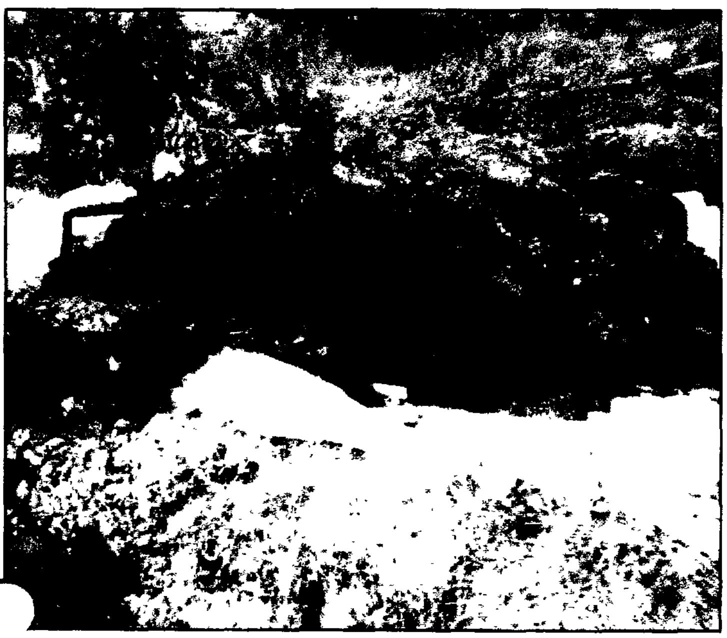
The waste was black in color and had an oily sheen. The waste was a mixture of metal (20 to 30 percent); glass (5 to 10 percent); wood waste (5 to 10 percent); and decomposed waste, rubber crumb and soil (50 to 60 percent). The metal portion of the waste was comprised of a water heater, 55-gallon drum, relatively large metal pieces (2 square feet and greater), pipe (1 to 2 inches in diameter), and wire. The wood portion of the waste contained pieces of plywood and other lumber.

Sample Description (G-TP7-W1):

Black very oily MUNICIPAL SOLID WASTE AND RUBBER CRUMB MIXTURE with some glass, metal, and pebbles. Sample headspace reading was 15 ppm total VOCs.

Sample Description (G-TP7-W2):

Black very oily MUNICIPAL SOLID WASTE with gray silty clay clods and oily pea gravel. Sample headspace reading was 10 ppm total VOCs.



G-TP8

Date:	23 August 1995
Overburden Thickness (feet):	0.5 to 1.0
Depth to Bottom of Waste (feet):	6.0 to 7.0
Depth to Ground Water (feet):	2.5 to 3.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	9.0
Samples (Depth (feet)):	G-TP8-W-1 (5.0) G-TP8-W-2 (6.0 to 7.0) G-TP8-S-1 (7.0 to 8.0)
Waste Temperature:	G-TP8-W-1: 80 degrees Fahrenheit

Test Pit Description:

The waste was black in color and had an oily sheen. The waste was a mixture of metal (15 to 20 percent); glass (5 to 10 percent); wood waste (5 to 10 percent); and decomposed waste, rubber crumb and soil (60 to 80 percent). The metal portion of the waste was comprised of relatively large pieces (2 square feet and greater), pipe (1 to 2 inches in diameter), and wire.

Sample Description (G-TP8-W1):

Black oily MUNICIPAL SOLID WASTE with some glass, metal (non ferrous), and pebbles. Sample headspace reading was not taken.

Sample Description (G-TP8-W2):

Black oily to very oily MUNICIPAL SOLID WASTE with some glass and metal (non ferrous). Sample headspace reading was not taken.

G-TP9

Date:	23 August 1995
Overburden Thickness (feet):	0.0
Depth to Bottom of Waste (feet):	Not encountered
Depth to Ground Water (feet):	0.5 to 1.0
Description of Soil Beneath Waste:	Not encountered
Bottom of Test Pit (feet):	4.5
Samples (Depth (feet)):	G-TP9-W-1 (0.0 to 4.0)

Test Pit Description:

The waste was a dark gray to black sludge with an oily sheen. The waste had very little strength; it was unable to support its own weight when placed in the stockpile and the walls of the test pit would not stay open. The waste was primarily comprised of rubbery waste, rubber crumb, decomposed waste, soil, and an oily liquid (ground water mixed with waste). It also contained roots, metal pipe, glass bottles, and pieces of plywood.

Sample Description (G-TP9-W1):

Black and dark gray very viscous oily TAR-LIKE MATERIAL. The sample also contained some large animal bones. The sample was not sieved due to its tar-like consistency. The sample had no apparent odor, but the sample headspace reading was 50-60 ppm total VOCs.

G-TP10

Date:	23 August 1995
Overburden Thickness (feet):	1.0 to 1.5
Depth to Bottom of Waste (feet):	6.0
Depth to Ground Water (feet):	1.5 to 2.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	7.0
Samples (Depth (feet)):	G-TP10-W-1 (4.0 to 5.0)

Test Pit Description:

The waste was black in color and had an oily sheen. The waste was a mixture of metal (5 to 10 percent); unbroken glass bottles (30 percent); glass (10 percent); and metal pipe (less than 5 percent); rubbery waste (10 to 20 percent); and decomposed waste, soil, and rubber crumb (40 to 50 percent). The rubbery waste was observed at a depth of 2 to 6 feet.

Sample Description (G-TP10-W1):

Black very oily TAR-LIKE MATERIAL AND MUNICIPAL SOLID WASTE MIXTURE with some rags, roots (organic), and glass. The sample also contained a small quantity of tan colored clay clods. The sample was not sieved due to its tar-like consistency. Sample headspace reading was 20 ppm total VOCs.

G-TP11

Date:	24 August 1995
Overburden Thickness (feet):	1.0
Depth to Bottom of Waste (feet):	5.0
Depth to Ground Water (feet):	4.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	6.0
Samples (Depth (feet)):	G-TP11-W-1 (4.0 to 5.0) G-TP11-S-1 (5.0 to 6.0)

Test Pit Description:

The waste was black in color and had an oily sheen. The waste was a mixture of metal (40 to 60 percent); glass (5 to 10 percent); wood (5 to 10 percent); and decomposed waste, soil, and rubber crumb (20 to 30 percent). The metal portion of the waste was comprised of pipe, wire, and metal that ranged in size from small pieces of rusted metal less than approximately 1 square inch to metal pieces greater than 2 square feet.

Sample Description (G-TP11-W1):

Black very oily MUNICIPAL SOLID WASTE AND SOIL MIXTURE with glass. Sample headspace reading was 0 ppm.

G-TP12

Date:	24 August 1995
Overburden Thickness (feet):	0.5
Depth to Bottom of Waste (feet):	6.5
Depth to Ground Water (feet):	4.5 to 5.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	8.0
Samples (Depth (feet)):	G-TP12-W-1 (5.5 to 6.0) G-TP12-W-2 (6.5) G-TP12-S-1 (7.0 to 8.0)

Test Pit Description:

The upper portion of waste (to a depth of approximately 3.0 to 4.0 feet) was dark brown in color and primarily a mixture of municipal solid waste and soil. This mixture included metal (5 to 10 percent), glass (5 to 10 percent), roots and lumber (less than 5 percent), and soil and decomposed waste (80 to 90 percent).

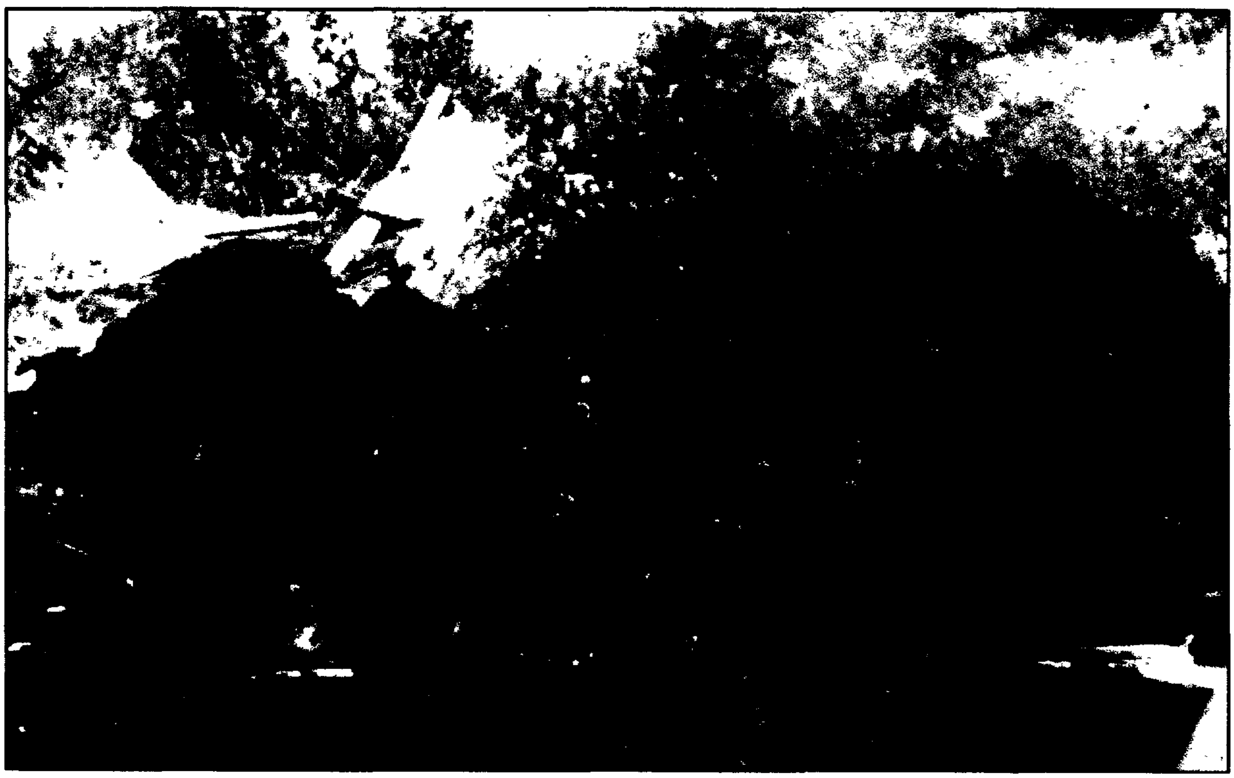
From an approximate depth of 3.0 to 4.0 feet to the bottom of the waste (6.5 feet), the waste was black in color. An oily sheen was observed on the waste at a depth of approximately 6.0 to 6.5 feet. The waste was a mixture of metal (5 to 10 percent); glass (5 to 10 percent); and decomposed waste, rubber crumb and soil (80 to 90 percent).

G-TP13

Date:	24 August 1995
Overburden Thickness (feet):	1.0 to 1.5
Depth to Bottom of Waste (feet):	8.5
Depth to Ground Water (feet):	8.0
Description of Soil Beneath Waste:	Gray silty CLAY with black stains
Bottom of Test Pit (feet):	9.5
Samples (Depth (feet)):	G-TP13-W-1 (5.0 to 6.0) G-TP13-S-1 (8.5 to 9.0)

Test Pit Description:

The upper portion of waste (to a depth of approximately 2.0) was dark brown in color and primarily a mixture of municipal solid waste (metal, glass, wood) and soil. The waste material below approximately 2 feet contained a dark brown to black mixture of decomposed waste, rubber crumb, rubbery waste, and soil. A piece of concrete approximately 3 feet in diameter and 3 to 4 inches thick was observed at a depth of approximately 3.0 feet.



NOMENCLATURE

Major sample components:	upper case letters used to describe predominant component (e.g., "MUNICIPAL SOLID WASTE"). When two or more predominant components could not be separated by hand or by sieving, the word "MIXTURE" is used (e.g. MUNICIPAL SOLID WASTE AND SOIL MIXTURE).
Secondary sample component:	adjective used if visually significant (e.g. "silty", "oily").
Third sample component:	the word "with" is used where component is less than secondary component, but still significant.
Fourth sample component:	the word "some" is used where component is less than third component, but is still significant.

DEFINITIONS

MUNICIPAL SOLID WASTE - This description is used for decomposed or partially decomposed material that probably originated as household waste, commercial solid waste, non-hazardous sludge, small quantity generator waste, or industrial solid waste. Typically the material categorized as municipal solid waste was a black detritus with occasional identifiable components (e.g. glass, wire, wood and other debris). It typically had a high moisture or liquid content, and an organic smell. In several cases, the material was classified as MUNICIPAL SOLID WASTE AND SOIL MIXTURE. This description was used when the material appeared to have a soil content (either granular or silty clay), but the soil fraction could not be physically separated by hand picking or by sieving. It is likely that the soil was originally added to the waste as a daily or intermediate cover. As the waste decomposed and was tracked over by heavy equipment, it likely became mixed with the waste.

RUBBER CRUMB - This description is used for small pieces (generally less than 1 inch in diameter) of black material that generally exhibited a high elasticity (i.e. when stretched or compressed would tend to rebound). The material appeared to have a high carbon-black content, and was observed in several states ranging from a tough fairly stiff rubber, to a semi-elastic material that was very tarry and sticky (almost caramel consistency). This material was present as a RUBBER CRUMB AND SOIL MIXTURE. It could be separated from the overall waste matrix as a mixture by sieving, but the mixture itself was not readily separated into soil and rubber components by sieving. The composition of the mixture was visually estimated to range from 80:20 (rubber:soil) to 50:50 (rubber:soil). At a few locations (generally near the east end of the North Dike), the material was oily but friable, and appeared to have a higher carbon-black content. The mixture had a strong odor of hydrocarbons (used motor oil), and generally gave a significant reading (i.e. greater than 10 ppm) on VOC monitoring equipment.

Silty CLAY - This description was used for soil that exhibited some plasticity, but also appeared to have a high silt content. Due to the presence of oils, tars and other waste materials, no attempt was made to distinguish between silty CLAY and clayey SILT.

TAR-LIKE MATERIAL - This term was used to describe black oily waste material that was a sticky, elastic, viscous substance that had a consistency of a rubbery sludge (similar to caramel or taffy). The material appeared to have a high organic content. The headspace readings for samples of this material ranged from 20 to 60 ppm total VOCs.

APPENDIX B

LABORATORY TESTING RESULTS

GEOSYNTEC CONSULTANTS

Geomechanics & Environmental Laboratory
5775 Peachtree Dunwoody Road, Suite 10D
Atlanta, Georgia 30342 • USA
Tel. (404) 705-9500 • Fax (404) 705-9300

28 September 1995

Mr. R. Neil Davies, P.E.
GeoSyntec Consultants
1100 Lake Hearn Drive, Suite 200
Atlanta, Georgia 30342

Subject: Final Report - Laboratory Test Results
Supplemental Site Investigation, North Dike Area
Bailey Superfund Site
Bridge City, Texas

Dear Mr. Davies:

GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia, is pleased to present the attached final test results (Tables 1 and 2 and Figure 1) for the above referenced project. A blank shown on any of the tables or the figure indicates that the test was not performed, the parameter is not applicable, or that the test resulted in insufficient data to report the designated parameter. Attachment A presents the general information pertinent to the testing program, and the policy of GeoSyntec regarding the limitations and use of the test results.

The Geomechanics and Environmental Laboratory appreciates the opportunity to provide testing services for this project. Should you have any questions regarding the attached test results or if you require additional information, please do not hesitate to contact either of the undersigned.

Sincerely,

Brian D. Jacobson

Brian D. Jacobson, E.I.T.
Assistant Program Manager
Environmental Testing

Nader S. Rad

Nader S. Rad, Ph.D., P.E.
Laboratory Director

Attachment

GE3913.05/GEL95281

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS
WASTE

BAILEY SITE SETTLORS COMMITTEE (BSSC)
SUPPLEMENTAL SITE INVESTIGATION, NORTH DIKE AREA

Site Sample ID	Lab Sample No	Moisture Content[1] ASTM D 2216 (%)	Percent Passing No. 4 Sieve (%)	Loss on Ignition[2][3][4] ASTM D 2947 (%)
G-TP1-W-1	E95I20	36.2	79.7	4 0
G-TP2-W-2	E95I21	38.4	100 0	46.8
G-TP3-W-1	E95I22	66.1	100.0	51.2
G-TP4-W-1	E95I23	41.5	84.9	13 5
G-TP5-W-2	E95I24	33.7	100.0	21.2
G-TP6-W-2	E95I25	56.9	87.0	30.1
G-TP7-W-1	E95I26	67 0	63.6	22.7
G-TP8-W-1	E95I27	41.8	85.6	14.3
G-TP11-W-1	E95I28	46.1	85.1	11.6

Notes:

1. Values were determined using a representative specimen of the bulk sample.
2. Testing was performed on the portion of the oven-dried material which passed through a standard No. 4 sieve.
3. Oven temperature was 824°F (440°C).
4. The Loss on Ignition (LOI) test is a measure of the weight of all organic material in the specimen. The Total Organic Carbon (TOC) test is a measure of the weight of only the organic carbon in the specimen.

TABLE 2

SUMMARY OF LABORATORY TEST RESULTS
SOIL

BAILEY SITE SETTLORS COMMITTEE (BSSC)
SUPPLEMENTAL SITE INVESTIGATION, NORTH DIKE AREA

Client Sample ID	Lab Sample No.	Sample Depth (ft)	Grain Size: Percent Passing #200 Sieve ASTM D 1140 (%)	Grain Size: ASTM D 422 Sieve Figure No.	Grain Size: ASTM D 422 Hydrom. Figure No.	Atterberg Limits ASTM D 4318: LL (%)	PL (%)	PI (-)	Soil Classification ASTM D 2487	Compaction ASTM D 698: Max Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Figure No.	Hydraulic Conductivity ASTM D 5084: Test Specimen Initial Conditions Dry Unit Weight (pcf)	Moisture Content (%)	Effective Stress (psi)	Hydraulic[1] Conductivity (cm/s)
G-TP5-S-1	E95I32		64.0	1		42	32	10	ML - Gravelly Silt with Sand							
G-TP6-S-1	E95I30		99.6			67	24	43	CH - Fat Clay				53.3	76.8	5	1.1E-7
G-TP8-S-1	E95I31		96.5			35	21	14	CL - Lean Clay				84.1	30.8	5	1.6E-7
G-TP11-S-1	E95I33		97.4			46	17	29	CL - Lean Clay							
G-TP12-S-1	E95I34		96.8			52	20	32	CH - Fat Clay							
G-TP13-S-1	E95I29		96.2			55	26	29	CH - Fat Clay				80.6	36.9	5	3.3E-7

Note:

1. The hydraulic conductivity values were determined using falling head hydralic gradients ranging from 12 to 3.

GEO SYNTEC CONSULTANTS
Geomechanics and Environmental Laboratory
Atlanta, Georgia

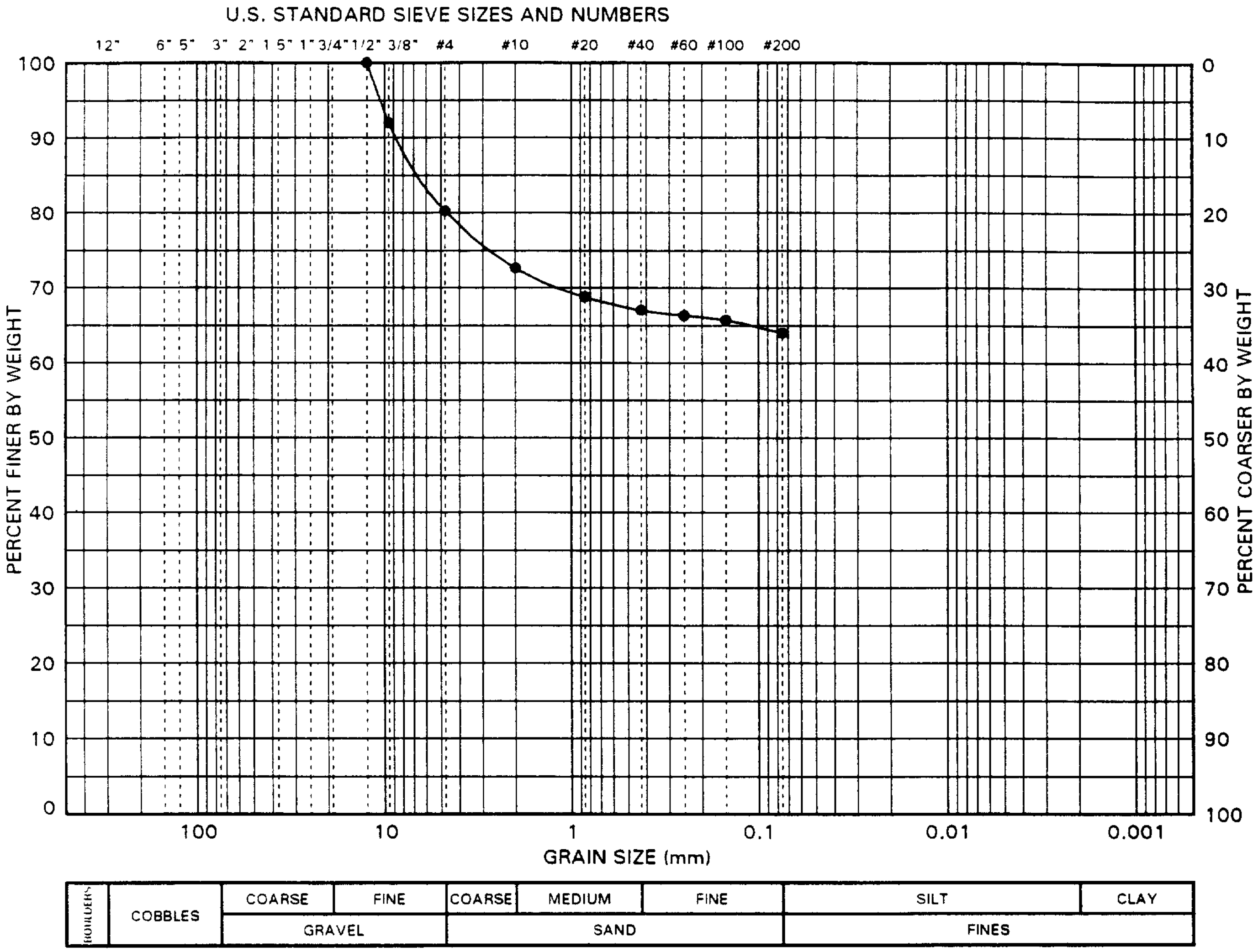
FIGURE 1

PROJECT:	BAILEY SITE - SSI - NORTH DIKE
PROJECT NO.:	GE3913
DOCUMENT NO.:	GEL95281

GS FORM
4PS2 09/27/95

PARTICLE SIZE DISTRIBUTION AND PHYSICAL PROPERTIES

ASTM C 136, D 422, D 2487
D 3042 AND D 4318



SITE SAMPLE ID G-TP5-S-1	LIQUID LIMIT (%)	42	SOIL FRACTIONS	GRAVEL (%)	19.7
LAB. SAMPLE NO. E95I32	PLASTIC LIMIT (%)	32		SAND (%)	16.3
SAMPLE DEPTH (ft)	PLASTICITY INDEX	10		FINES (%)	64.0
SOIL CLASSIFICATION: ML - Gravelly Silt with Sand				SILT (%)	
				CLAY(%)	
				COEFF. UNIFORMITY (Cu)	
				COEFF. CURVATURE (Cc)	

PERCENT PASSING U.S. STANDARD SIEVE SIZES AND NUMBERS														PERCENT FINER THAN HYDROMETER PARTICLE DIAMETER (mm)				
3"	2"	1.5"	1"	3/4"	1/2"	3/8"	#4	#10	#20	#40	#60	#100	#200					
PERCENT PASSING SIEVE SIZES (mm)																		
75	50	37.5	25	19	12.5	9.5	4.75	2.00	0.850	0.425	0.250	0.150	0.075	0.050	0.020	0.005	0.002	0.001
100	100	100	100	100	100	92	80	73	69	67	66	66	64					

NOTES:

ATTACHMENT A

Sample Identification, Handling, Storage and Disposal

Laboratory Test Standards

Application of Test Results

SAMPLE IDENTIFICATION, HANDLING, STORAGE AND DISPOSAL

Test materials were sent to GeoSyntec Consultants (GeoSyntec) Geomechanics and Environmental Laboratory in Atlanta, Georgia by the client or its representative(s) Samples delivered to the laboratory were identified by client sample identification (ID) numbers which had been assigned by representative(s) of the client Upon being received at the laboratory, each sample was assigned a laboratory sample number to facilitate tracking and documentation.

Based on the information provided to GeoSyntec by the client or its representative(s) and, when applicable, procedural guidelines recommended by an industrial hygiene consultant, the following Occupational Safety and Health Administration (OSHA) level of personal protection was adopted for handling and testing of the test materials:

[ ] test materials were not contaminated, no special protection measures were taken;
[X] level D
[ ] level C
[ ] level B

In accordance with the health and safety guidelines of GeoSyntec, contaminated materials are stored in a designated containment area in the laboratory. Non-contaminated materials are stored in a general storage area in the laboratory.

GeoSyntec Geomechanics and Environmental Laboratory will continue storing the test materials for a period of 30 days from the date of this report or a year from the time that the samples were received, which ever is shorter. Thereafter: (i) contaminated materials will be returned to the client or its designated representative(s); and (ii) the materials which are not contaminated will be discarded unless long-term storage arrangements are specifically made with GeoSyntec Geomechanics and Environmental Laboratory.

LABORATORY TEST STANDARDS

At the request of the client, the laboratory testing program was performed utilizing the guidelines provided in the following test standards:

[X] **moisture content** - American Society for Testing and Materials (ASTM) D 2216 "*Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures*";

[ ] **moisture content** - ASTM D 4643 "*Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Method*";

[X] **particle-size analysis** - ASTM 422, "*Standard Method for Particle-Size Analysis of Soils*";

[X] **percent passing No. 200 sieve** - ASTM D 1140, "*Standard Test Method for Amount of Material in Soil Finer Than No. 200 (75 microns) sieve*";

[X] **Atterberg limits** - ASTM D 4318, "*Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*";

[X] **soil classification** - ASTM D 2487, "*Standard Test Method for Classification of Soils for Engineering Purposes*";

[ ] **soil pH** - ASTM D 4972, "*Standard Test Method for pH of Soils*";

[ ] **soil pH** - United States Environmental Protection Agency (USEPA) SW-846 Method 9045, Revision 1, 1987, Standard Test Method for Measurement of "*Soil pH*";

[ ] **specific gravity** - ASTM D 854, "*Standard Test Method for Specific Gravity of Soils*";

[ ] **carbonate content** - ASTM D 3042, "*Standard Method for Insoluble Residue in Carbonate Aggregates*";

[ ] **soundness** - ASTM C 88, *"Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate"*;

[X] **loss-on-ignition (LOI)** - ASTM D 2974, *"Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"*;

[ ] **standard Proctor compaction** - ASTM D 698, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop"*,

[ ] **modified Proctor compaction** - ASTM D 1557, *"Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop"*;

[ ] **maximum relative density** - ASTM D 4253, *"Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table"*;

[ ] **minimum relative density** - ASTM D 4254, *"Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"*,

[ ] **mass per unit area** - ASTM D 3776, *"Standard Test Method for Mass Per Unit Area (weight) of Woven Fabric"*,

[ ] **thickness measurement** - ASTM D 1777, *"Standard Test Method for Measuring Thickness of Textile Materials"*;

[ ] **free swell** - United States Pharmacopeia National Formulary (USP-NF) XVII, *"Swell Index of Clay"*;

[ ] **fluid loss** - American Petroleum Institute (API)-13B, *"Section 4, Bentonite"*;

[ ] **marsh funnel** - API-13B, *"Section 4, Field Testing of Oil Mud Viscosity and Gel Strength"*;

[ ] **pinhole dispersion** - ASTM D 4647, *"Standard Test Method for Identification and Classification of Dispersive Clay Soils by the Pinhole Test"*;

[ ] **gradient ratio** - ASTM D 5101, *"Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio"*;

[ ] **hydraulic conductivity ratio** - Draft ASTM D 35 03.91.01, *"Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing"*;

[ ] **hydraulic transmissivity** - ASTM D 4716, *"Standard Test Method for Constant Head Hydraulic Transmissivity (In-plane flow) of Geotextiles and Geotextile Related Products"*;

[ ] **one-dimensional consolidation** - ASTM D 2435, *"Standard Test Method for One-Dimensional Consolidation Properties of Soil"*;

[ ] **one-dimensional swell/collapse** - ASTM D 4546, *"Standard Test Method for One-Dimensional Swell or Settlement Potential of Cohesive Soils"*;

[ ] **unconfined compressive strength (UCS)** - ASTM D 2166, *" Standard Test Method for Unconfined Compressive Strength of Cohesive Soil"*;

[ ] **triaxial compressive strength ($\overline{\text{ICU}}$)** - ASTM D 4767, *"Standard Test Method for Triaxial Compression Test on Cohesive Soils"*;

[ ] **triaxial compressive strength (UU)** - ASTM D 2850, *"Standard Test Method for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression"*;

[ ] **rigid wall constant head hydraulic conductivity** - ASTM D 2434, *"Standard Test Method for Permeability of Granular Soils (Constant Head)"*;

[X] **flexible wall falling head hydraulic conductivity** - ASTM D 5084, *"Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter"*;

[ ] **flexible wall falling head hydraulic conductivity** - U S Army Corp of Engineers; EM-1110-2-1906, *"Standard Test Method for Permeability Tests, Appendix VII"*,

[ ] **index flux of GCL** - proposed ASTM method rough draft # 1, 6/18/94, *"Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"*;

[ ] **flexible wall falling head hydraulic conductivity** - Geosynthetic Research Institute (GRI) GCL-2, *"Standard Test Method for Permeability of Geosynthetic Clay Liners (GCLs)"*;

[ ] **permeability/compatibility** - USEPA Method 9100, SW-846, Revision 1, 1987, Standard Test Method for Measurement of *"Saturated Hydraulic Conductivity, Saturated Leachate Conductivity and Intrinsic Permeability"*;

[ ] **capillary-moisture** - ASTM D 2325, *"Standard Test Method for Capillary-Moisture Relationships for Coarse- and Medium-Textured Soils by Porous-Plate Apparatus"*;

[ ] **capillary-moisture** - ASTM D 3152, *"Standard Test Method for Capillary-Moisture Relationships for Fine-Textured Soils by Pressure-Membrane Apparatus"* and

[ ] **paint filter liquids** - USEPA Method 9095, SW-846, Revision 1, 1987, *"Paint Filter Liquids Test"*.

APPLICATION OF TEST RESULTS

The reported test results apply to the field materials inasmuch as the samples sent to the laboratory for testing are representative of these materials. This report applies only to the materials tested and does not necessarily indicate the quality or condition of apparently identical or similar materials. The testing was performed in accordance with the general engineering standards and conditions reported. The test results are related to the testing conditions used during the testing program. As a mutual protection to the client, the public, and GeoSyntec, this report is submitted and accepted for the exclusive use of the client and upon the condition that this report is not used, in whole or in part, in any advertising, promotional or publicity matter without prior written authorization from GeoSyntec.

APPENDIX C

SELECTED REFERENCES

United States
Environmental Protection
Agency

Center for Environmental
Research Information
Cincinnati OH 45268

Risk Reduction
Engineering Laboratory
Cincinnati OH 45268

Technology Transfer

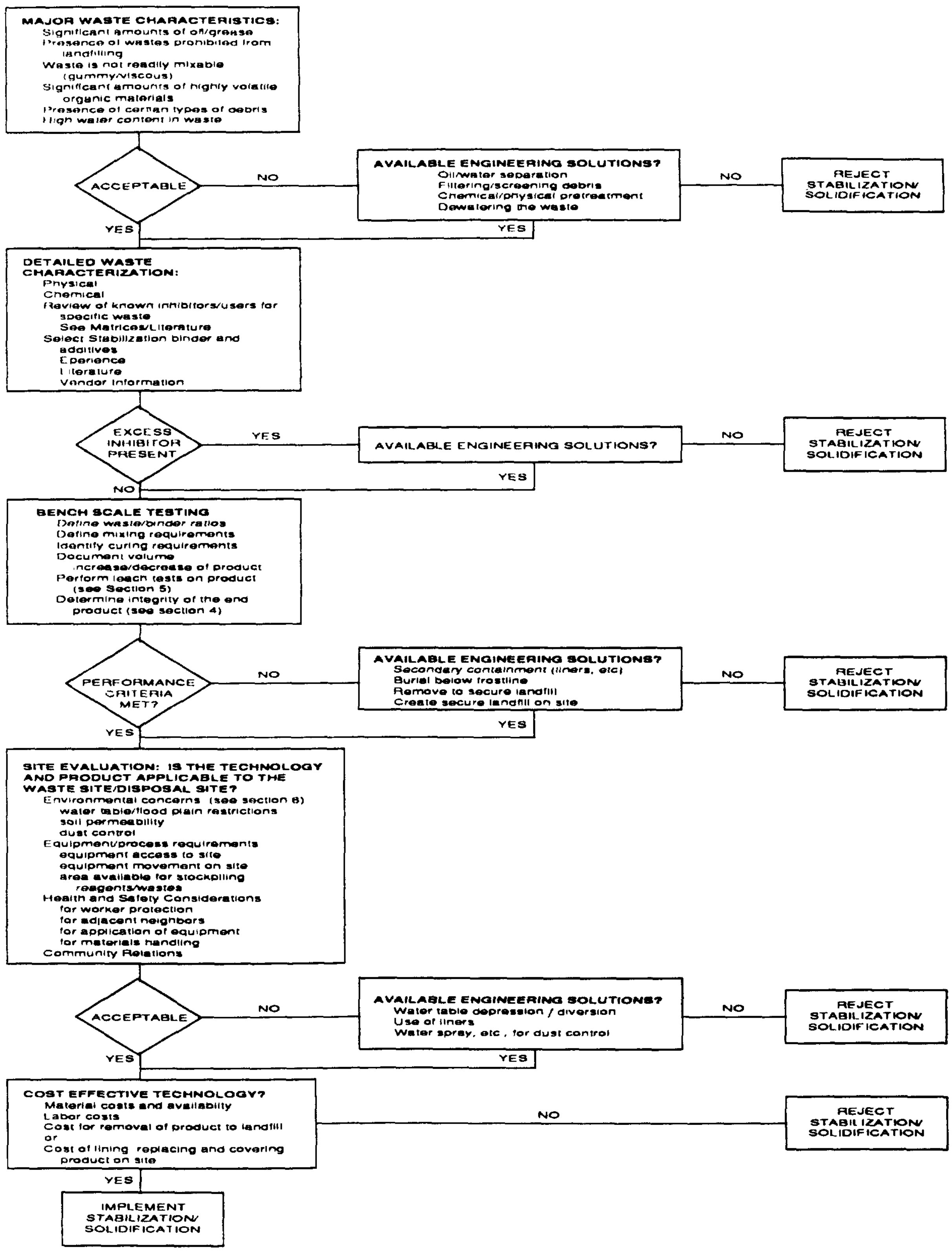
EPA/625/6-89/022

EPA

Stabilization/ Solidification of CERCLA and RCRA Wastes

Physical Tests, Chemical Testing Procedures, Technology Screening, and Field Activities

Figure 6-1. Technology screening flowchart for stabilization/solidification.



APPENDIX D

INDEPENDENT PROFESSIONAL OPINION BY KIBER ENVIRONMENTAL SERVICES, INC.

TECHNICAL MEMORANDUM
BAILEY LANDFILL SUPERFUND SITE
NORTH DIKE AREA

1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

Kiber Environmental Services, Inc. (Kiber) was contracted by GeoSyntec Consultants (GeoSyntec) to provide an independent professional opinion regarding the feasibility of stabilization/solidification treatment for the North Dike Area at the Bailey Superfund Site. The scope of services was authorized by Mr. Neil Davies of GeoSyntec during a meeting at Kiber's offices on 25 September 1995. All data and information referenced herein was provided to Kiber by GeoSyntec, unless otherwise noted.

1.2 SCOPE OF WORK

Supplemental site investigations were performed by GeoSyntec Consultants during August, 1995. Kiber understands that the objective of these investigations was to provide additional information regarding the material properties and characteristics within the North Dike Area. The following information was provided to Kiber:

- Appendix A: Supplemental Site Investigation, summary of test pit logs;
- Appendix B: Laboratory Test Results, loss on ignition;
- Waste characterization results (Table 2, and Figures 2 through 10);
- Photographs taken during excavation of supplemental test pits; and
- Video documentation of the test pit excavations.

Copies of Appendix A, Appendix B and the waste characterization results are presented as attachments.

Kiber was requested by GeoSyntec to develop a technical opinion regarding the feasibility of stabilization treatment for the North Dike Area based on Kiber's review of the above-referenced information. Note that Kiber was only provided with raw data pertaining to site investigations performed by GeoSyntec. In certain discussions, Kiber has also referenced previous information gathered by Kiber at the Bailey Site.

1.3 PREVIOUS EVALUATIONS

Kiber feels that initial feasibility evaluations performed for the site lacked sufficient detail to adequately assess the feasibility of stabilization treatment and containment. Later information developed for the Site, including 1) additional stabilization evaluations and waste/soil interface investigations performed by Harding-Lawson Associates, 2) pilot-scale and full-scale treatment performed in the East Dike Area, and 3) contractor treatability studies performed on the North Marsh materials, provided pertinent information regarding the feasibility of stabilization treatment for the Bailey Site. However, none of these studies or projects provide detailed information relative to the physical characteristics of the materials contained within the North Dike Area. Harding-Lawson Associates (HLA) performed an elaborate testing program to define the waste/soil interface, and to determine a more accurate volume estimate for stabilization treatment. However, the boring and trenching logs obtained by HLA do not include adequate material descriptions of the North Dike Area.

It is Kiber's opinion that previous information generated for the Bailey Site, prior to the test pits excavated by GeoSyntec, does not adequately characterize the North Dike Area materials. The previous information cannot be extrapolated to evaluate the feasibility of stabilization for the North Dike Area. Specifically:

1. The original North Dike Area investigations performed by HLA were insufficient to adequately assess stabilization treatment in that 1) trenching was only performed along the edge of the dike in order to define the waste/soil interface, and 2) soil borings were performed along the center of the dike even though it was believed that a significant amount of municipal debris was present within the North Dike Area.

2. No attempt was made to define the amount of tar-like material. A significant quantity of tar is present in the Pit B area and the North Marsh. Detailed information pertaining to the extent of tar within the North Dike Area is deficient. HLA's descriptions indicate that the North Dike Area materials are composed

primarily of 1) black and cindery waste, 2) industrial and municipal waste, 3) black rubbery waste, and 4) black oily or tar-like waste.

3. Discussions with representatives of HLA indicated that the North Dike Area contains a significant amount of wood, metal and glass debris; and oversized debris including appliances, car bodies, wood, tree roots, and so forth. There appears to be no detailed documentation or delineation as to the extent of this debris.

4. Limited treatability testing using boring trimmings was performed on the North Dike Area waste materials that may not adequately represent the majority of the materials within the North Dike Area.

In May 1995, Kiber was contracted by the Bailey Site Settlors Committee to develop an independent evaluation of stabilization treatment for the North Dike Area based on 1) cursory review of existing data available prior to the test pits excavated by GeoSyntec, 2) Kiber's previous experience at the Bailey Site during the pilot demonstration performed in October 1994, and 3) a visit to the Bailey Site by Kiber's technical personnel on 6 June 1995. Kiber references this previous work throughout this technical memorandum.

To summarize, the evaluations performed by Kiber for the BSSC concluded that the materials within the North Dike Area were not readily amenable to stabilization treatment. However, selective stabilization followed by containment was identified as a potential remedy for selected locations within the North Dike Area.

2.0 REVIEW OF TEST PIT DATA

The data generated by GeoSyntec provides pertinent information regarding the implementation and potential effectiveness of stabilization treatment for the North Dike Area. Review of the supplemental test pit data indicates that the primary waste material within the North Dike Area may be significantly different than originally documented. Kiber believes that the supplemental test pit excavations represent the material contained within the North Dike Area. In comparison to the HLA investigations, the test pit evaluations performed by GeoSyntec were excavated approximately along the center of the North Dike Area. Kiber believes that the supplemental investigations accurately represent the North Dike Area materials.

Review of the supplemental data shows that the total waste composition of the North Dike Area materials consists of approximately 39% rubber/soil waste, 26% municipal solid waste with soil, 12% silty/clayey soil, 10% glass, 8% tar and 5% other debris. The other debris consists of oversized stones, metal and wood blended with soil. GeoSyntec referred to the rubber fragments as rubber crumb. The rubber crumb generally exhibited high elasticity, and varied from tough fairly stiff rubber, to a semi-elastic material that was very tarry and sticky. The material exhibited total organic contents, as obtained through loss on ignition evaluations, ranging from 4 to 51%. A large percentage of oily tar (approximately 8%) was also observed.

Treatment of the elastic rubber and tar material will result in operational difficulties during full-scale treatment. The material was described by GeoSyntec as having a caramel consistency. Based on Kiber's experience with similar tar materials at the Bailey Site, it is clear that these tarry materials will be difficult to excavate, handle and stabilize using conventional construction equipment. The previously selected stabilization technique for the Bailey Site includes *in situ* auger stabilization. A recent full-scale demonstration at the McColl Superfund Site located in California showed that full-scale productivity may be negatively impacted by the presence of tar-like materials. Kiber's experience at the McColl Site indicates that the presence of tar-like materials will often result in clogging of the reagent injection ports; thereby, reducing productivity. Excessive clogging of the injection ports may result in inadequate stabilization.

Previous discussions by Kiber with HLA representatives indicated that the majority of the North Dike Area consists of metal and glass fragments resulting from municipal waste disposal. Due to the municipal nature of the North Dike Area, HLA indicated that there are areas containing large oversized debris such as car bodies, appliances, boards, trees, cement blocks and so forth. Review of the GeoSyntec information shows that the North Dike Area materials contain a significantly greater percentage of municipal waste than originally believed. The test pit excavations uncovered glass bottles, oversized wood debris, metal pipes, sheet metal fragments (>2 ft^2), concrete rubble, large tree roots, 55-gallon drums and even a hot water heater.

The presence of the oversized debris seriously limits the ability of *in situ* stabilization to effectively treat the materials. Kiber's experience indicates that *in situ* treatment may be appropriate up to a maximum particle diameter of three inches. In order to effectively use *in situ* stabilization treatment for the North Dike Area, all oversized debris would need to be removed prior to remediation. The metal, wood, tree and pipe fragments will inhibit *in situ* auger operations.

Ex situ treatment is inappropriate for the majority of the North Dike Area materials due to the extensive material processing required prior to actual stabilization. Kiber typically recommends that *ex situ* treatment be performed using maximum particles sizes in the range of 3/8 inch to 1/2 inch. Therefore, extensive material processing would be required for implementation of the full-scale treatment. Material handling requirements would involve excavation, transport, temporary storage, pre-screening for bulk particle size removal (i.e., concrete rubble, appliances, metal pipes and so forth), and crushing. GeoSyntec indicated that handpicking and screening of the waste materials was difficult at best.

Based on Kiber's previous work in the East Dike Area pilot demonstration, treatability testing of the North Marsh wastes, and review of the GeoSyntec data, *in situ* stabilization of the Pit B waste materials is inappropriate, and *ex situ* treatment difficult. However, Kiber believes that selective treatment of these materials, although difficult, may be required since these materials pose the greatest environmental impact, threat for mobility, and geotechnical instabilities.

3.0 CONCLUSIONS

In summary, Kiber feels that the original feasibility study lacked the detail and focus required to adequately assess the feasibility of stabilization and containment once identified as the preferred remedy. The supplemental site investigation performed by GeoSyntec clearly shows that the materials present in the North Dike Area are not amenable to effective stabilization treatment using either *in situ* or *ex situ* processes. *In situ* and *ex situ* stabilization treatment cannot be practically implemented given the large quantity of oversized wood, glass, metal fragments and rubber/tar. However, selective stabilization treatment is recommended for portions of the Pit B area.

Prepared for:

United States Environmental Protection Agency
Region 6
1445 Ross Avenue
Dallas, Texas 75202

FOCUSED FEASIBILITY STUDY REPORT
Revision 1

BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Submitted by:

Bailey Site Settlors Committee

Prepared by:

GEOSYNTEC CONSULTANTS
1100 Lake Hearn Drive, NE, Suite 200
Atlanta, Georgia 30342

Project Number GE3913-14

September 1996

EXECUTIVE SUMMARY

This document has been prepared by GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia, on behalf of the Bailey Site Settlors Committee (BSSC) in support of the focused feasibility study (FFS) for the Bailey Superfund Site, located in Orange County, Texas. This Focused Feasibility Study Report (FFSR) represents the work product of Task 10 of the *"Work Plan for Focused Feasibility Study, Revision 1, Bailey Superfund Site, Orange County, Texas"* (Work Plan). GeoSyntec submitted the Work Plan to the United States Environmental Protection Agency, Region 6 (USEPA) on 15 August 1995, and USEPA approved the Work Plan on 16 August 1995.

Previous remedial activities at the Bailey Superfund Site ceased in early 1994 as a result of difficulties in implementing the previously selected remedy. As a result, USEPA requested that BSSC evaluate the feasibility of implementing the remedy and perform an FFS to identify whether more expedient and effective remedial actions are available.

The overall objectives of the FFS, as presented in the Work Plan, are as follows:

- develop and evaluate remedial alternatives capable of controlling or eliminating current and/or future human and ecological exposure pathways (i.e., evaluate alternatives that meet the threshold criterion of protecting human health and the environment);

- analyze the technical equivalency of the remedial alternatives by comparing the performance of the remedial alternatives to the original remedial design;

- estimate the cost of the remedial alternatives and schedules needed to implement the remedy; and

- identify the most cost-effective remedial alternative to control or eliminate current and/or future human and ecological exposure pathways; consideration would also be given to the long-term aesthetics, operation and maintenance of the completed remedy; this remedial alternative will be proposed as the basis for remedial design.

To achieve these objectives, the following initial tasks were performed:

- activity-specific work plans were prepared and submitted to USEPA for review and comment;
- existing site data were reviewed, inventoried, evaluated, and assembled in a manner that would aid retrieval of data;
- a supplemental site investigation was performed for the North Dike Area of the site; the resultant data were used to evaluate the technical feasibility of implementing the original remedial design for this area;
- a supplemental site investigation was performed for the North Marsh Area of the site; the resultant data were used to evaluate: (i) the feasibility of implementing the original design for this area; (ii) other potential remedial alternatives; and (iii) the possibility of addressing the North Marsh Area remediation as an independent activity that would occur in early 1996; and
- supplemental site investigations were performed for the East Dike Area and Pit B; the resultant data were used to evaluate: (i) the technical feasibility of implementing the original remedial design for the East Dike Area; and (ii) potential treatment and disposal options for the Pit B wastes.

Details of these initial activities are described in the technical memoranda appended to this FFSR. The conclusions of the supplemental site investigations are presented below.

North Dike Area

Based on the additional data obtained during the supplemental site investigations, GeoSyntec concluded the following:

- solidification of the waste within the North Dike Area to the specified performance criteria is technically infeasible and should be eliminated from further consideration;

- solidification of certain "hot spots" or localized areas of the North Dike Area may be appropriate if it is evaluated to be necessary as a component of the revised remedy; and

- if solidification is used as a component of a revised remedy for "hot spot" areas, the performance requirements should be evaluated and amended; new performance requirements should be developed that are both implementable and consistent with the engineering requirements of the revised remedy.

East Dike Area

"As part of the supplemental East Dike Area site investigation, GeoSyntec evaluated the solidification component of the original remedy for the waste within this area using the logical framework used to evaluate the waste within the North Dike Area. GeoSyntec concluded that successful in-situ solidification of the waste within the East Dike Area to the specified performance criteria is technically infeasible, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified.

In addition, according to the Record of Decision (ROD) for the Bailey Superfund Site, the functions of solidification are to "reduce the mobility of the wastes and provide strength to support the cap." Based on the results presented in this report, the wastes in the East Dike Area have adequate strength to support a final cover system and solidification for this purpose is not needed.

North Marsh Area, Pit B, and Pit A-3

Surficial tarry waste was present in the North Marsh Area which borders the northern side of the North Dike Area. This waste extended from the edge of the North Dike Area to a distance of up to 150 ft (46 m) into the marsh. Tarry waste was also present in Pit B, which is located at the western end of the North Dike Area. Based on the results of investigations performed in the North Marsh Area and Pit B, USEPA prepared an Explanation of Significant Differences (ESD) for each of these areas to allow the waste to be excavated and disposed of at an appropriately-permitted off-site landfill. In addition, material from Pit A-3 was relocated and consolidated into the East Dike Area, in accordance with the requirements of the original ROD. The remedial action for each of these areas was completed during January to July 1996. Since this work is complete, the remediation of the North Marsh Area, Pit B, and Pit A-3 is not included as part of this FFSR.

Identification and Preliminary Screening of Process Options

This task included the identification and preliminary screening of process options. Process options within the following remedial technologies were considered for the Bailey Superfund Site:

- capping;
- vertical subsurface barriers;
- in-situ treatment; and
- removal/ex-situ treatment/disposal.

Secondary Screening of Process Options

This task included a secondary screening of process options retained following the preliminary screening and a rating of the process options. As a result of the secondary screening activities, process options were retained for: (i) the entire site; and (ii) isolated "hot-spot" areas.

Process options retained for the entire site were as follows:

- lightweight composite cap;
- consolidation water collection system;
- slurry wall; and
- polymeric membrane wall.

Process options retained for isolated "hot-spot" areas were as follows:

- sheet pile walls;
- in-situ solidification–alternate performance criteria;
- in-situ solidification–method-based specification; and
- off-site disposal.

Analysis of Technical Equivalency

A potential remedial alternative (PRA) was assembled from process options retained for the entire site. The analysis of technical equivalency was used to compare the PRA to the original remedial design (ORD) in terms of effectiveness (i.e., source containment performance). The analyses indicate that the long-term performance of the PRA is superior to the ORD in terms of source control. The short-term performance of the PRA is also superior to the ORD for all areas, assuming that a consolidation water collection system is installed within the upper portion of the waste mass, construction is properly sequenced, and existing surface-water management measures are continued during implementation of the PRA.

Development and Assembly of Remedial Alternatives

In this task, the components of the ORD were assembled as a basis for comparing the ORD to the alternate remedial design (ARD). The ARD was developed and assembled into a remedial alternative using the major elements of the PRA. This task also included the preparation of a course of action during the initial stages of the remedial design that would result in the development and selection of a remedy for areas where tarry wastes may be present.

The ARD consists of the components described below:

General Site Construction

The following components are general construction activities to be performed as a part of the ARD:

- consolidation of site debris and cleared vegetation into areas that will be capped;

- installation of a consolidation water collection system to intercept and remove ground water that rises in the short term (i.e., during construction of the cap) due to consolidation of the waste; this water will be treated using the on-site treatment facility;

- installation of stormwater management controls to treat stormwater runoff from disturbed areas during construction and divert stormwater runoff from inactive or completed areas of the site to the marsh;

- grading of both the previously solidified area and the unsolidified area using general fill to provide a slight slope to the cap for stormwater control; and

- construction of permanent access roads.

East Dike Area

Components of the ARD specific to the East Dike Area include:

- modification of previously constructed flood control dikes (modifications will include adjustment of top elevations, repair/modifications of areas that have experienced excessive settlement or failure, and erosion/slope protection); and

- construction of a lightweight composite cap and related appurtenances over both the previously solidified and unsolidified areas of waste.

North Dike Area

Components of the ARD specific to the North Dike Area include:

- modifications to the existing dikes and side slopes (i.e., adjustment of top elevations as necessary to tie into the cap, and erosion protection); and
- construction of a lightweight composite cap and related appurtenances over areas of waste.

Local "Hot Spot" Remediation

If an isolated "hot spot" area is identified before or during the revised remedial action, the selection of a remedy for this area would be addressed as a preliminary remedial design activity or as a remedial action activity. In general, "hot spot" areas of the site have been addressed as interim actions during the conduct of the FFS. Therefore, the likelihood of identifying additional "hot spots" at the Bailey Superfund Site is considered low. The types of "hot spots" that could conceivably be discovered include localized soft zones of the site that may exist as a result of the disposal of low strength wastes (e.g., tars, oils, or other liquids). If such an area is encountered, the remedial design for this area would then be developed as follows:

- implement an investigation to: (i) estimate the total volume of waste and affected soils; and (ii) characterize the waste physically and chemically;
- evaluate the process options retained from the secondary screening and those process options that satisfy the requirement of technical equivalency, using the USEPA nine-point criteria;
- prepare and submit a technical memorandum or letter to USEPA that would recommend a remedial alternative for the "hot spot" area; and
- develop a design for the "hot spot" area concurrently with the remedial design for the other areas of the site or as a remedial action activity.

Detailed Analysis of Remedial Alternatives

In this task, a detailed analysis of the ORD and ARD was performed. The analysis was performed using criteria established by USEPA, and consisted of a two-step process. First, each design was analyzed individually using the USEPA nine-point criteria. Second, a comparative analysis was performed to evaluate the relative performance of the ARD with respect to the ORD.

The detailed analysis of the alternatives indicates that the ARD performs better than the ORD when evaluated with respect to the USEPA nine-point criteria. The ARD is equally or more protective to human health and the environment and is therefore recommended as the basis for development of a revised remedial design for the Bailey Superfund Site.

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FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
ARD	Alternative Remedial Design
ASTM	American Society for Testing and Materials
BSSC	Bailey Site Settlors Committee
Chem Waste	Chemical Waste Management, Inc.
CPT	Cone Penetration Test
CWCS	Consolidation Water Collection System
Engineering-Science	Engineering-Science, Inc.
ESD	Explanation of Significant Differences
FFS	Focused Feasibility Study
FFSR	Focused Feasibility Study Report
FS	Feasibility Study
GCL	Geosynthetic Clay Liner
GeoSyntec	GeoSyntec Consultants
HDPE	High Density Polyethylene
HELP	Hydrological Evaluation of Landfill Performance
HLA	Harding Lawson Associates
McLaren/Hart and Kiber	McLaren/Hart Environmental Engineering Corporation and Kiber Environmental Services, Inc.
MSW	Municipal Solid Waste
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operations and Maintenance
ORD	Original Remedial Design
PAH	Polyaromatic Hydrocarbon
PID	Photoionization Detector
PRA	Potential Remedial Alternative
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RD	Remedial Design
RI	Remedial Investigation

LIST OF ABBREVIATIONS AND ACRONYMS (continued)

ROD	Record of Decision
ROM	Rough Order-of-Magnitude
RI/FS Guidance	Guidance for Conducting Remedial Investigations and Feasibility Studies
SACM	Superfund Accelerated Cleanup Model
SER	Stabilization Evaluation Report
SI	International System of Units
TCLP	Toxicity Characteristic Leaching Procedure
TM-EDA/PB	Technical Memorandum, Supplemental East Dike Area and Pit B Site Investigations
TM-NDA	Technical Memorandum, Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy
USEPA	United States Environmental Protection Agency
WCC	Woodward-Clyde Consultants
Work Plan	Work Plan for Focused Feasibility Study, Revision 1
WSF	Weighted Source Flux

1. INTRODUCTION

1.1 Terms of Reference

This document has been prepared by GeoSyntec Consultants (GeoSyntec), Atlanta, Georgia, on behalf of the Bailey Site Settlors Committee (BSSC) in support of the focused feasibility study (FFS) for the Bailey Superfund Site, located in Orange County, Texas. This Focused Feasibility Study Report (FFSR) represents the work product of Task 10 of the "*Work Plan for Focused Feasibility Study, Revision 1, Bailey Superfund Site, Orange County, Texas*" [GeoSyntec, 1995a] (Work Plan). GeoSyntec submitted the Work Plan to the United States Environmental Protection Agency, Region 6 (USEPA) on 15 August 1995, and USEPA approved the Work Plan on 16 August 1995.

1.2 Project Background

The Bailey Superfund Site is located approximately 3 mi (5 km) southwest of Bridge City in Orange County, Texas. The site was originally part of a tidal marsh near the confluence of the Neches River and Sabine Lake. In the early 1950s, Mr. Joe Bailey constructed two ponds (Pond A and Pond B) at the site as part of the Bailey Fish Camp. The ponds were reportedly constructed by dredging the marsh and piling the marsh sediments to form dikes along the northern and eastern limits of Pond A (the North Dike Area and the East Dike Area, respectively). Between the time of construction (1950s) and the spring of 1971, Mr. Bailey used a variety of wastes including industrial wastes, municipal solid waste (MSW), and debris as fill material for these dikes.

In 1984, USEPA proposed the site for inclusion on the National Priorities List (NPL). The site was placed on the NPL in 1986. A remedial investigation (RI) was completed for the site in October 1987 [Woodward-Clyde Consultants (WCC), 1987], and a feasibility study (FS) was completed in April 1988 [Engineering-Science, Inc. (Engineering-Science), 1988]. The RI concluded that: (i) the site has had no impact on drinking water; and (ii) in the unlikely event that site constituents were to migrate via a ground-water pathway, it would take over 800 years for them to reach potable ground water. The shallow ground water beneath and adjacent to the site is saline and not suitable for human consumption. The closest public water supply well, located approximately 1.5 mi (2.4 km) northeast of the site, is estimated to be approximately 385 ft (117 m) deep. The nearest municipal water supply wells are located approximately 2.6 mi (4.2 km) northeast of the site and have a reported depth of approximately 585 ft (173 m). There has been no development in the immediate vicinity of the Bailey Superfund Site, nor is it likely to be suitable for future development due to prohibitions against development in wetlands areas. No air emissions above ambient conditions were detected during air monitoring activities conducted during RI field activities.

In the FS report, Engineering-Science recommended in-situ solidification of the on-site waste and construction of a clay cap over the waste as the preferred remedy for the site. USEPA selected this remedy in the Record of Decision (ROD) for the site, signed on 28 June 1988 [USEPA, 1988a]. As presented in the ROD, "*the components of the selected remedy include:*

- *Relocation of affected sediments from the marsh* (North Marsh Area) *and drainage channel, as well as waste from the drum disposal area and pit A-3, to the Waste Channel* (North Dike Area)*; and*
- *stabilization of the Waste Channel* (North Dike Area) *and the Area East of Pond A* (East Dike Area) *using the technique developed during remedial design.*"

According to the ROD for the Bailey Superfund Site, the functions of solidification are to "*reduce the mobility of the wastes and provide strength to support a clay cap.*" The clay cap was to be installed over the solidified waste. The goals and objectives of the selected remedy included in the ROD are "*to minimize the potential for waste migration and the potential for short-term air emissions resulting from remediation.*"

The remediation area comprises the North Dike Area, East Dike Area, and North Marsh Area, as shown in Figure 1-1. The North Dike Area is approximately 3,000 ft (914 m) long by 130 ft (40 m) wide, and the East Dike Area is approximately 1,200 ft (366 m) long by 220 ft (67 m) wide. Surficial tarry waste was present in the North Marsh Area which borders the northern side of the North Dike Area [GeoSyntec, 1995c]. This waste extended from the edge of the North Dike Area to a distance of up to 150 ft (46 m) into the marsh. Tarry waste was also present in Pit B, which is located at the western end of the North Dike Area [GeoSyntec, 1996a and 1996b]. Based on the results of investigations performed in the North Marsh Area and Pit B, USEPA prepared an Explanation of Significant Differences (ESD) for each of these areas to allow the waste to be excavated and disposed of at an appropriately-permitted off-site landfill. In addition, material from Pit A-3 was relocated and consolidated into the East Dike Area, in accordance with the requirements of the original ROD. The remedial action for each of these areas was completed during January to July 1996. Since this work is complete, the remediation of the North Marsh Area, Pit B, and Pit A-3 is not included as part of this FFSR.

A remedial design (RD) for the selected remedy was developed by Harding Lawson Associates, Houston, Texas (HLA) and a construction contract for the implementation of the remedial action (RA) was awarded to Chemical Waste Management, Inc. (Chem Waste) in 1992. The RD specified that the on-site waste be solidified to a minimum unconfined compressive strength of 25 psi (172 kPa) and a hydraulic conductivity of not more than 1×10^{-6} cm/s. During initial attempts to solidify waste in the East Dike, Chem Waste encountered difficulties in achieving the specified physical and hydraulic performance criteria (i.e., unconfined compressive strength and hydraulic conductivity) for the solidified waste. As a result of these difficulties, work on the RA eventually ceased. Remedial activities completed prior to the cessation of work include the construction of a dike around the East Dike Area of the site, and partial solidification of waste within the southern portion of the East Dike Area.

After Chem Waste stopped work, the BSSC retained independent contractors and consultants to perform a pilot study to evaluate the feasibility of implementing the original remedial design (i.e., in-situ solidification) at a location in the East Dike Area. The study indicated that successful in-situ solidification could be achieved at that location in general conformance with the specified performance criteria. The study concluded, however, that to meet the specified performance criteria, conformance testing needed to be based on wet sampling of uncured material, followed by laboratory curing, rather than coring of material cured in-situ (as had initially been performed in accordance with the construction specifications) [McLaren/Hart Environmental

Engineering Corporation and Kiber Environmental Services, Inc., (McLaren/Hart and Kiber), 1995]. Importantly, the study did not address the feasibility of solidification in other areas of the site (i.e., the North Dike Area and the northern-middle and northern portions of the East Dike Area). The data and information collected during the RI, RA, and subsequent investigations indicate that the waste in the North Dike Area is deeper and more heterogeneous than the waste in the area of the pilot study. These data also indicate that wastes in the North Dike Area and the northern and middle portions of the East Dike Area include MSW, debris, rubber crumb, and tarry waste which, based on both USEPA and industry experience, are difficult and costly to effectively solidify.

Based on RA activities at the site to date, the BSSC concluded that solidification of waste at the site to the physical and hydraulic performance criteria specified by the RD will be, at a minimum, difficult, time consuming, and costly to implement. Recognizing this fact, USEPA requested BSSC to further evaluate the feasibility of solidification of the waste at the site and perform a FFS to identify whether more expedient and effective remedial actions for the site may be available.

1.3 Objectives of the Focused Feasibility Study

The FFS was developed as a means to identify whether a more expedient and effective design approach is available for remediation of the Bailey Superfund Site. As presented in the Work Plan, the overall objectives of the FFS are as follows:

- develop and evaluate remedial alternatives capable of controlling or eliminating current and/or future human and ecological exposure pathways (i.e., evaluate alternatives that meet the threshold criterion of protecting human health and the environment);

- analyze the technical equivalency of the remedial alternatives by comparing the performance of the remedial alternatives to the original remedial design;

- estimate the cost of the remedial alternatives and schedules needed to implement the remedy; prepare comparative cost estimates (to an approximate accuracy of plus 50 percent to minus 30 percent); and

- identify the most cost-effective remedial alternative to control or eliminate current and/or future human and ecological exposure pathways; consideration would also be given to the long-term aesthetics, operation and maintenance of the completed remedy; this remedial alternative will be proposed as the basis for remedial design.

GeoSyntec utilized the National Contingency Plan (NCP), Superfund Accelerated Cleanup Model (SACM), and current USEPA guidance to focus the evaluation. Previously generated documents and data for the site and new information acquired while performing the FFS were used to streamline the FFS process and to support choices made during the original FS.

1.4 Organization of Focused Feasibility Study

The organization of the remainder of this FFSR is as follows:

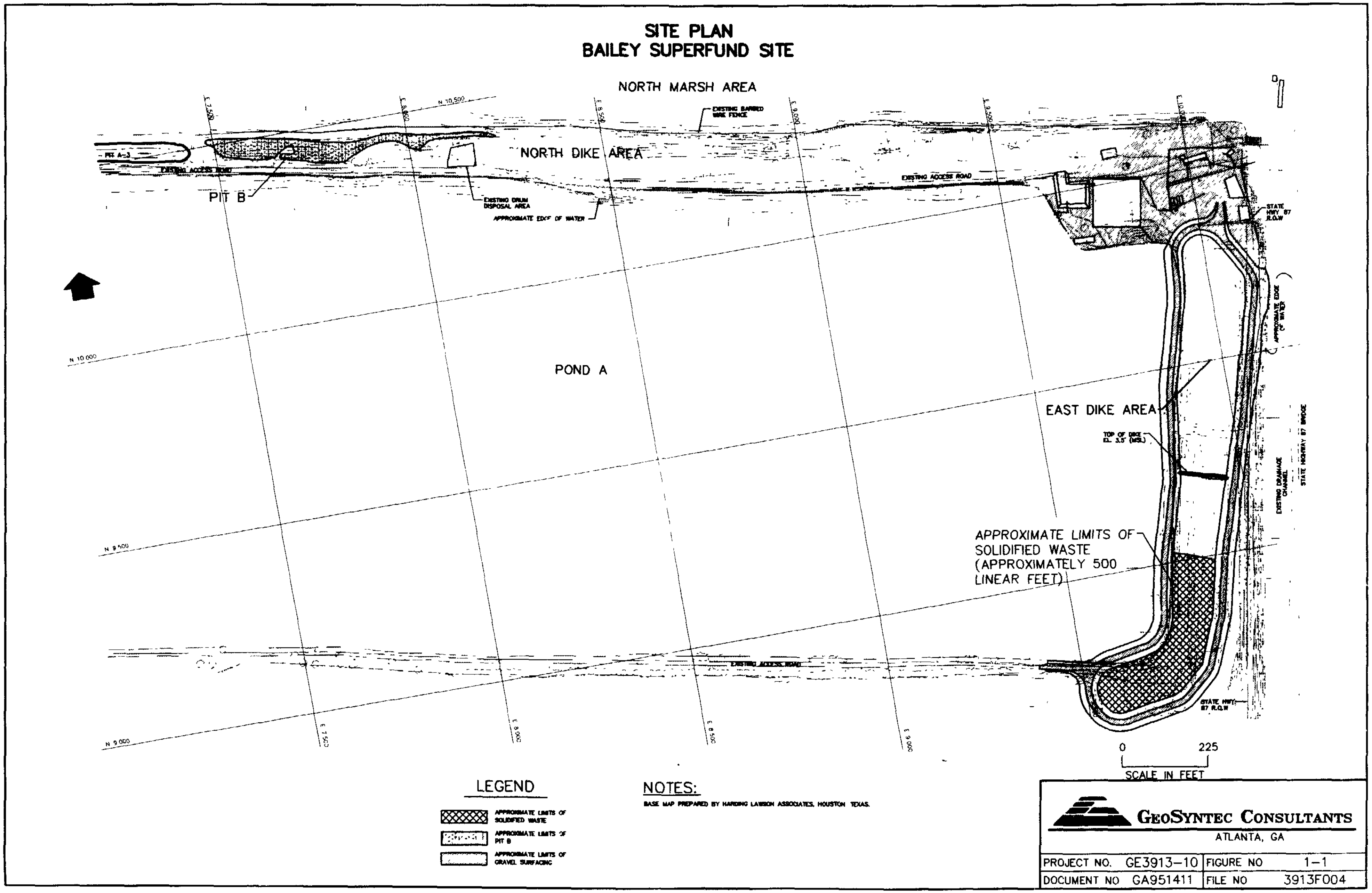
- a brief review of data generated during investigations of the Bailey Superfund Site prior to the commencement of this FFS is presented in Section 2;
- an overview of the additional site investigations performed for this FFS is presented in Section 3; details of the additional site investigations are presented in the appendices to this document;
- remedial action objectives are presented in Section 4;
- general response actions considered for the site are presented in Section 5;
- identification and screening of process options are presented in Section 6;
- secondary screening of process options is presented in Section 7;
- analysis of technical equivalency is presented in Section 8;

- the development and assembly of remedial alternatives is presented in Section 9;

- the detailed analysis of alternatives is presented in Section 10; and

- references used within this document are provided in Section 11.

INSERT FIGURE 1-1 HERE


SITE PLAN
BAILEY SUPERFUND SITE
NORTH MARSH AREA
EXISTING BARBED WIRE FENCE
NORTH DIKE AREA
PIT B
EXISTING ACCESS ROAD
EXISTING DRUM DISPOSAL AREA
APPROXIMATE EDGE OF WATER
STATE HWY 87 R.O.W
POND A
EAST DIKE AREA
TOP OF DIKE EL 3.5' (MSL)
EXISTING DRAINAGE CHANNEL
STATE HIGHWAY 87 BRIDGE
APPROXIMATE LIMITS OF SOLIDIFIED WASTE (APPROXIMATELY 500 LINEAR FEET)
STATE HWY 87 R.O.W
N 10,500
N 10,000
N 9,500
N 9,000
E 7,500
E 8,000
E 8,500
E 9,000
0
225
SCALE IN FEET
LEGEND
APPROXIMATE LIMITS OF SOLIDIFIED WASTE
APPROXIMATE LIMITS OF PIT B
APPROXIMATE LIMITS OF GRAVEL SURFACING
NOTES:
BASE MAP PREPARED BY HARDING LAWSON ASSOCIATES, HOUSTON, TEXAS.
GEOSYNTEC CONSULTANTS
ATLANTA, GA
PROJECT NO. GE3913-10
FIGURE NO 1-1
DOCUMENT NO GA951411
FILE NO 3913F004

2. PREVIOUS INVESTIGATIONS

2.1 Overview

This section of the FFSR presents a brief overview of the various investigations performed at the site prior to implementation of the FFS Work Plan. These investigations were performed as part of the remedy selection and development process for the original remedial design. This section is not intended as an all inclusive summary, but is intended to: (i) document the main elements of the work performed prior to the commencement of the FFS; and (ii) identify data gaps that lead to the performance of the supplemental site investigations as part of the FFS.

2.2 North and East Dike Areas

2.2.1 Remedial Investigation (RI)

As part of the site remedial investigation (RI), WCC advanced numerous borings into the North Dike Area of the site (referred to as the Waste Channel area in the RI report). The RI report indicates that a total of 66 borings were completed of which 12 were "*individual soil/waste borings and 54 borings were traverse borings completed to identify the limit of the waste.*" The depths of the borings ranged from 6 to 22 ft (1.8 to 6.7 m). Section 4.2.2.1 of the RI includes the following narrative:

> "*Wastes deposited in this area consist of both municipal and industrial wastes, which are commonly intermixed. The municipal waste is comprised of fragments of glass, metal and wood, along with miscellaneous rubble and trash. Glass marbles and rusty material were also noted. The industrial wastes are black and of variable consistency, usually granular and crumbly to rubbery. The material varies from very soft to hard. The waste is occasionally tarry in consistency, particularly along traverse RWCT-15. The industrial waste often is intermixed with municipal waste and/or soil fill, and occasionally interlayered with municipal waste and/or soil fill. Also, the waste is sometimes described as oily; typically, this occurs below the level of*

groundwater saturation. So, the description "oily" likely reflects increased moisture content rather than a different type of waste material."

In addition, the RI report indicates that a total of 97 borings and 17 posthole probes were completed in the East Dike Area (referred to at the Area East of Pond A in the RI report). Thirty-three of the borings were "*individual soil/waste borings and 54 borings were traverse borings.*" The depths of the borings ranged from 6 to 20 ft (1.8 to 6.1 m) and the posthole probes were approximately 4 ft (1.2 m) deep. Section 4.2.3.1 of the RI report includes the following:

"*Wastes deposited in the Area East of Pond A generally consist of black industrial wastes. Municipal wastes are much less abundant than in the Waste Channel area. Some municipal rubble was observed in the northern third of the Area East of Pond A (traverses RET-1, -7, and -12; boring REB-10). This material consisted of fragments of glass and metal, bricks, burnt trash, and miscellaneous rubble.*

The industrial wastes encountered in this area generally tended to be less tar-like and rubbery and more granular than those encountered in the Waste Channel area. A black, powdery waste material was frequently encountered in the upper foot of borings, often as apparent road fill material. Also, chunks of black waste were strewn across the ground surface, particularly in the southern half of the area.

The industrial waste was occasionally intermixed with soil and/or municipal fill, but apparently to a lesser degree than in the Waste Channel area."

A review of the RI boring logs and other data (Appendix E of the RI report) indicates that jar samples of the waste were collected during the field activities. The boring logs indicate that in some cases, pocket penetrometer shear strength readings and photoionization detector (PID) readings were taken on the samples. However, it appears that little attempt was made to evaluate the composition of the waste, other than visual classification of boring samples. The emphasis of the investigation appears to have been on defining the lateral and vertical extent of the waste and the nature of contamination resulting from the waste, not on evaluating the composition of the waste.

2.2.2 Feasibility Study

Engineering-Science performed additional field and laboratory investigations during the feasibility study (FS). The focus of the FS was on characterizing the waste for purposes of evaluating certain remedial alternatives (e.g., solidification, landfilling, incineration, deep well injection, and wastewater biological treatment). The FS report presents data to demonstrate that solidification of the waste reduces the mobility of certain waste constituents. The FS report also includes data to demonstrate improvements in the geotechnical properties of the solidified waste as compared to unsolidified waste material.

For the FS, Engineering-Science performed testing on two composite samples that were identified as being representative of the North Dike Area and East Dike Area. According to Appendix E of the FS, each composite sample was made from discrete borings advanced into the two waste disposal areas. The sample from the North Dike Area (designated "BWC") was comprised of discrete samples collected from fifteen 10- to 12-ft (3.0- to 3.7-m) deep borings in the North Dike Area, whereas the East Dike Area sample (designated "BEA") was comprised of samples collected from thirteen 10- to 12-ft (3.0- to 3.7-m) deep borings in the East Dike Area. The FS states that both hollow stem auger and air rotary drilling methods were employed to advance the borings and Shelby tubes were used to collect the samples. Where the waste was too wet or oily to collect with Shelby tubes, samples were obtained from the drill cuttings using a hand trowel.

For the FS report, Engineering-Science evaluated the effectiveness of solidification by comparing chemical and physical test results for unsolidified waste samples and solidified waste samples (using different solidification admixtures and mix proportions). The evaluation was made using data from toxic characteristic leaching procedure (TCLP) testing (USEPA Method 1311) and geotechnical physical/mechanical property testing. The geotechnical testing included evaluation of the following parameters:

- paint filter (USEPA Method 9095);
- moisture content (ASTM D 2216);

- liquid and plastic limits (ASTM D 4318);
- bulk density (ASTM D 2922 or D 2937);
- physical description (ASTM D 2488);
- soil pH (USEPA Method 9045);
- optimum moisture content and dry density (ASTM D 558);
- unconfined compressive strength (ASTM D 1632, ASTM D 1633);
- wetting-and-drying durability (ASTM D 559, Method B); and
- permeability (ASTM D 3877).

The data included in the FS report demonstrate that solidification of the waste samples reduced the mobility of certain waste constituents (determined by TCLP testing) and improved the geotechnical properties of the waste.

2.2.3 Stabilization Evaluation Report (SER)

The performance of an in-situ stabilization evaluation program was a requirement of the Consent Decree for the site. A work plan to meet this requirement was developed and implemented by HLA between August and December 1990. The objectives of the evaluation were to:

- further characterize the chemical and physical properties of the waste at the site;
- subdivide the area to be remediated into stabilization sectors;
- define the appropriate stabilization admixtures for each sector; and
- evaluate the physical and hydrogeological characteristics of the North Marsh Area levee for use in the remedial design.

The field investigation program consisted of the following:

- drilling and sampling 11 geotechnical borings adjacent to the waste areas to investigate the engineering properties of surrounding soils for design purposes;
- drilling and sampling 18 borings in the waste areas designated in the RI/FS;
- excavating 15 trenches with a backhoe to collect additional waste material to augment or supplement waste samples obtained from the borings;
- compositing samples from waste borings and trenches for a subsequent laboratory admixture stabilization evaluation and analytical (TCLP) testing of unsolidified and solidified waste;
- performing 15 cone penetration tests (CPT) in the waste areas to evaluate the effectiveness of the cone as a tool to delineate waste boundaries during remediation; additionally, the cone penetrometer was used to collect geotechnical data necessary for remedial design; and
- performing a field audit to verify that the procedures outlined in the RD Work Plan and Quality Assurance Project Plan (QAPP) were being followed, and to identify any required modifications to these procedures.

HLA prepared a "*Stabilization Evaluation Report*" [HLA, 1991a] (SER) which describes the results of the in-situ stabilization evaluation program. According to the SER, bulk samples of waste were obtained for visual classification and geotechnical laboratory and analytical testing. The majority of the waste borings advanced during this program were drilled using a track-mounted drill rig and hollow stem augers. Shelby tube, split-spoon, and bucket type samplers were used to obtain samples for logging purposes. Drill cuttings were collected and added to the boring samples to provide a sufficient volume of sample for the admixture stabilization evaluation.

The SER also addresses the thickness of waste in areas of interest. For example:

"The waste borings indicated an industrial waste thickness as thin as 0.8 feet at HLA-3 in Pit B and as thick as 10.5 feet at HLA-8 north of Pond A. The average depth of waste along the East Side of Pond A was 5.0 feet...."

As part of the in-situ stabilization evaluation program, 15 trenches were excavated in both the North Dike Area and the East Dike Area. According to the SER, the trenches were performed to provide additional sample volume for the admixture stabilization evaluation program. Waste profile descriptions, PID readings, and pocket penetrometer measurements were also taken during the trenching.

In general, HLA described regions of the North Dike Area as containing the following waste types:

- *"Black Cindery Waste*
    - *dry, soft*
    - *high PID readings up to 500 ppm*
    - *boulder size rubbery chunks, oily at depth, no municipal waste noted."*
- *"Industrial and Municipal Waste*
    - *saturated, very loose to hard, cemented blocks discovered*
    - *excavation likely required during remedial action*
    - *black cindery and rubbery wastes with boards, trees, tires, and appliances."*
- *"Black Rubbery Waste*
    - *saturated, soft*
    - *with tar-like and cindery layers*
    - *large amounts of municipal waste."*
- *"Black Cindery and Rubbery Waste*
    - *moist, soft*
    - *with some tar-like waste, no municipal waste noted."*

HLA described regions of the East Dike Area as containing the following waste types:

- "*Black Cindery Waste*
  - *dry, soft*
  - *some municipal waste*
  - *soft, with gravel size rubbery waste.*"

- "*Black Cindery Waste*
  - *saturated, soft*
  - *some rubbery chunks, no municipal waste noted.*"

The SER presents the results of a three-phase evaluation procedure performed by HLA. A performance criterion for the solidified waste of an unconfined compressive strength of 25 psi (172 kPa) was developed. An unconfined compressive strength of 50 psi (344 kPa), as measured by a pocket penetrometer, was used as a screening criterion in Phase I of their evaluation. The 50 psi (344 kPa) value used in Phase I of the SER was apparently derived by multiplying the 25 psi (172 kPa) performance criterion by two to provide a factor of safety. During Phases II and III, the 25 psi (172 kPa) performance criterion was used.

For the Phase I evaluation, physical and chemical properties of the unstabilized waste were evaluated to provide a baseline for comparison with the properties of the stabilized wastes. During Phase I, three admixture types (cement, flyash, and lime kiln dust) were evaluated at different admixture rates. Phase I testing was performed using a pocket penetrometer to assess the potential effectiveness of each admixture. Samples that had an unconfined compressive strength equal to or greater than approximately 50 psi (345 kPa) after curing for 72 hours, as measured with the pocket penetrometer, were selected for the Phase II evaluation.

Phase II of the testing program consisted of confirming the unconfined compressive strength of the samples that passed the Phase I evaluation using a modified form of ASTM D 1633. The goal was to estimate the amount of admixture required to attain a unconfined compressive strength of 25 psi (172 kPa).

Phase III of the testing program consisted of evaluating physical properties of the stabilized waste including: (i) unconfined compressive strength (after being immersed in site ground water for 31 days); (ii) moisture content; (iii) dry density; and (iv) hydraulic conductivity. The summary of the admixture evaluation included the following narrative:

> "*In general, it has been found that the waste at the site can be stabilized with an admixture of 10 to 20 percent cement and meet the minimum strength and permeability requirements with a resulting decrease in mobility of a majority of the metals present. Sample Areas 8 and 9*[1] *were better stabilized when treated with lime kiln dust due to their high oil and grease concentrations.*"

In addition, the data included in the SER demonstrate that solidification of the waste samples reduced the mobility of certain waste constituents, as demonstrated by comparing TCLP testing results of unsolidified and solidified waste samples.

The SER also includes a literature study and evaluation of the following stabilization techniques:

- inject and mix;
- shallow soil mixing;
- track mounted mixing;
- pneumatic spreading;
- closed loop consolidation; and
- excavation/stabilization.

The summary of the literature study and evaluation of stabilization techniques includes the following discussion:

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[1] Sample Area 8 consists of Pit B and the east end of Pit A-3. Sample Area 9 is located east of Pit B.

"The best suited stabilization techniques include inject and mix, and area excavation (excavate, stabilize, and replace). The inject and mix technique is well suited for areas having only small quantities of debris mixed with the waste. Where large amounts of debris are present, area excavation will be required."

2.2.4 Evaluation of Data Obtained Prior to the Start of the Remedial Action

The RI focused on defining the nature and extent of waste present at the site. Materials identified during the RI include MSW, industrial waste, rubble, and debris. The RI report also indicates the presence of tarry and oily wastes.

The FS focused on the evaluation of potential remedial alternatives for the Bailey Superfund Site and included an evaluation of the effectiveness of solidification. Effectiveness was evaluated on the basis of an overall reduction in the mobility of the waste constituents (based on TCLP testing of unsolidified and solidified waste samples), and by improvements to the geotechnical properties (primarily compressive strength and hydraulic conductivity) of the waste.

The stabilization evaluation program was performed as part of the RD effort, and was a requirement of the Consent Decree. The SER presents the findings of the evaluation program. Data gathered during the evaluation program expanded on the FS efforts and was used to support the following:

- evaluation of appropriate admixtures;
- evaluation of in-situ stabilization methods;
- evaluation of appropriate quality assurance/quality control (QA/QC) methods; and
- delineation of various areas of the site that may need special consideration.

An important observation is that the above evaluations were essentially based on samples obtained from borings using split-spoon, Shelby tubes, or small bucket samplers to collect the samples. In some cases, drill cuttings were added to the samples so that a sufficient amount of material would be available for the laboratory testing. These sampling methods are not effective for collecting samples that contain large-sized waste particles and viscous wastes. The use of these methods resulted in samples having maximum particle sizes on the order of 1 to 2 in. (25 to 51 mm) in greatest dimension and the sampling methodology would exclude significant portions of debris, MSW, liquid, and tarry components.

It appears that only limited attempts were made to study or evaluate the physical composition of the waste at a macro-scale (i.e., extent of large items such as debris, cable, wood, and metal items that could interfere with solidification methods). Also, the waste was not adequately evaluated at the micro-scale in that little attempt was made to identify individual components in the waste with respect to particle size, percentage composition, and the presence of oil, grease, organics, or other potential solidification inhibitors. A thorough evaluation of both the macro- and micro-composition of the waste is considered to be important with respect to making a complete evaluation of the technical feasibility of the various solidification methods.

In summary, it appears that insufficient data were gathered during the RI, FS, and RD investigations and studies to make decisions regarding the full scale implementability of the solidification component of the original remedial design.

2.2.5 Summary of East Dike Area In-Situ Solidification Efforts

Chem Waste was awarded the construction contract for the implementation of the RD in 1992. This contract included the solidification of both the North Dike Area and the East Dike Area, the latter of which was to be solidified first. Difficulties were encountered while implementing the solidification component of the original remedial design in the southern portion of the East Dike Area. This resulted in the cessation of the RA work in January 1994, largely due to difficulties in attaining the specified performance criteria for hydraulic conductivity and unconfined compressive strength. These specified performance criteria were measured by testing samples cored from the solidified waste. It is important to note that the area of the East Dike Area solidified during the RA corresponds approximately to the area referred to as Sample Area No. 7

in the SER. According to Table 1 of the SER, the waste in the area is described as follows:

- *"Black Cindery Waste*
  - *saturated, soft*
  - *some rubbery chunks, no municipal waste noted"*

Also, according to the waste isopach map (Drawing 2B of the SER), the waste depth in Sample Area No. 7 is typically 3 to 4 ft (0.9 to 1.2 m) deep with isolated pockets up to approximately 7 ft (2.1 m) deep. In contrast, the SER indicates that the waste in the North Dike Area is comprised of MSW, tar-like and cindery layers, and cindery and rubbery waste that is deeper than the waste in the East Dike Area (i.e., the waste is both deeper and has a different composition to the East Dike Area).

After Chem Waste stopped work, the BSSC retained independent contractors and consultants to perform a pilot study. The findings of the pilot study are addressed below.

2.2.6 In-Situ Stabilization Pilot Demonstration

Between 19 October and 26 October 1994 (i.e., after cessation of construction activities), McLaren/Hart and Kiber performed an in-situ stabilization pilot demonstration program in the East Dike Area, slightly north of the area solidified by Chem Waste. This demonstration program was performed under contract to the BSSC. The findings were presented in a report entitled "*In-Situ Stabilization Pilot Demonstration - Final Report*" [McLaren/Hart and Kiber, 1995].

The executive summary of the report states the following:

"The field work consisted of the in-situ stabilization of two test sections in material which was deemed representative for the waste areas requiring in-situ stabilization. One area was stabilized with a mixture of cement and bentonite and one area with the addition of 20% cement, the minimum amount required in the initial performance-based Technical Specifications. During this field work a variety of QA/QC measures were taken and documented. The stabilized

material was subsequently sampled in the uncured (wet sampling) and cured (hardened) state using various methods. The sampling methods were chosen based on general industry practices, the initial Technical Specifications, and based on methods previously utilized at the Site. Samples obtained from these various methods were then sent to Kiber's laboratory in Atlanta, Georgia.

Laboratory testing, consisting primarily of unconfined compressive testing and permeability testing, (were performed) *on the various samples obtained from the pilot demonstration. The results of this testing indicated that the wet samples yielded acceptable test results which met the initial Technical Specifications and were consistent with the test results achieved during the bench-scale treatability study which was performed prior to the field work. The test results from the samples obtained in the cured state using drilling techniques yielded unacceptable test results. Visual observations of these samples indicated that these samples had microfractures which in our opinion are due to disturbance during sampling operations. These findings were consistent with our experience, and the experience of others in this field on similar stabilization projects. Further, additional longer term testing of the wet samples and cured samples showed that the wet sample continued to gain strength with time, while the cured samples showed no significant strength gains with time, an indication that these samples have be*(en) *sufficiently disturbed after initial curing.*

Based on the in-situ pilot demonstrations performed by McLaren/Hart and Kiber, review of the Technical Specifications, the experience of McLaren/Hart, Kiber and others in the industry, we have concluded the following:

- *The waste material can be stabilized to the required depths and areal extent, using in-situ technology and non-propriet*(ar)*y admixtures, and;*

- *The waste material can be stabilized such that the stabilized material has a minimum unconfined compressive strength of 25 psi and a maximum permeability of* 1×10^{-6} *cm/sec, consistent with the overall intent of the Contract Documents.*

The above conclusions are based on using wet sampling methods for Contract acceptance. This would require the approval of a sampling modification in accordance with the Field Order or Change Order process.

It is also the opinion of McLaren/Hart and Kiber that the reproducibility of meeting the Technical Specifications during full-scale work is very good. Based on the above conclusions, it is our opinion that no additional in-situ stabilization pilot studies are necessary for the East Waste Disposal Area."

It is important to note that both pilot demonstration areas (Area A and Area B) were located in the southern-middle portion of the East Dike Area. Correlating this back to the SER, the locations were approximately at the mid-point between SER Sample Areas No. 2 and No. 7. Descriptions of the waste at these locations, as presented in the SER, are as follows:

- *"Sample Area No. 2*
  Black Cindery Waste
  - *dry, soft*
  - *some municipal waste*
  - *soft, with gravel size rubbery waste."*

- *"Sample Area No. 7*
  Black Cindery Waste
  - *saturated, soft*
  - *some rubbery chunks, no municipal waste noted."*

The maximum reported treatment depth at the pilot demonstration areas (maximum difference between the surface and the bottom of the treatment area) is 10 ft (3m). A review of the waste isopach map for this area (Drawing 2B of the SER) suggests that the waste depth at the pilot area may only be 3 to 5 ft (0.9 to 1.5 m) deep (i.e., the material that was solidified may not all be waste).

3. SUPPLEMENTAL SITE INVESTIGATIONS

3.1 Overview

This section presents the supplemental site investigation and testing activities performed during the implementation of the FFS. As stated in Section 2.2.4, data gathered during the selection and development of the original remedial design were insufficient to make decisions regarding full-scale implementability of the solidification component of the original remedial design.

Test pits were excavated in the North Dike Area and East Dike Area so that the composition and nature of the disposed waste could be evaluated. The supplemental site investigation performed in the North Dike Area coincides with Task 4 of the initial Work Plan. The supplemental site investigation performed in the East Dike Area was not included in the Work Plan, but was performed following the identification of data gaps for this area, and with the prior approval of USEPA.

3.2 North Dike Area

Detailed information regarding the supplemental site investigation and evaluation of the original remedial design for the North Dike Area is presented in a document entitled "*Technical Memorandum, Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy*" [GeoSyntec, 1995b] (TM-NDA). This document is included in this FFSR as Appendix A. The objectives, findings, and conclusions of the TM-NDA are summarized below.

The supplemental site investigation was performed to better define the composition and nature of the waste material in the North Dike Area. Previous investigations and studies did not sufficiently characterize these materials for an evaluation of the technical feasibility of solidification/stabilization technologies (i.e., waste component types, particle size, heterogeneity, and presence of solidification inhibitors).

The field work consisted of excavating thirteen test pits in the North Dike Area. The excavation of each test pit was carefully logged and documented to provide an estimation of the gross composition of the wastes. Bulk samples were obtained at several depths from each test pit. The bulk samples were hand sorted and sieved to estimate the composition and particle size distribution of the smaller waste fractions.

Laboratory testing consisted of testing selected waste samples for loss on ignition to estimate the percentage of organic material in the waste. Soil samples taken from beneath the waste were also tested to evaluate certain physical properties that will be used in the evaluation of alternative remedies.

Based on the results of the field investigations and laboratory testing, GeoSyntec concluded that a variety of municipal and industrial wastes were co-disposed in the North Dike Area. These wastes include municipal waste, large items of debris, tarry waste, rubber crumb, and other rubbery waste. In addition, the waste has a high organic content (4 to 51 percent as measured by loss on ignition).

GeoSyntec also evaluated the solidification component of the original remedy in accordance with the screening processes presented in *"Stabilization/ Solidification of CERCLA and RCRA Wastes"* [USEPA, 1989]. Although this document does not provide definitive information on whether a specific waste can be solidified, it provides a logical framework for evaluating the potential treatability of a specific waste. The observations made during the test pit excavations and the subsequent waste sorting and testing activities provide the data used to evaluate the treatment component of the original remedy. A summary of the evaluation is presented below.

Due to the oily and tarry nature of the waste components and the heterogeneity of the waste, mechanical sorting at either a pilot or full scale would be difficult and costly to implement. Therefore, pilot-scale testing is not considered appropriate or viable. Even if the waste could be mechanically separated to remove debris, the separation of the organic component of the waste would not be feasible since it is widely dispersed within many components of the waste matrix. In addition to the waste pre-treatment issues, other logistical limitations at the site would result in high implementation costs, especially when compared to the benefits achieved. These limitations include: (i) space requirements for processing; (ii) work associated with waste excavation and dewatering; (iii) air emissions during processing; and (iv) disposal of residuals.

Based on the volume, composition, heterogeneity, and organic content of the waste, GeoSyntec concluded that successful in-situ solidification of the waste in the North Dike Area to the specified performance criteria is technically infeasible. Successful implementation of the in-situ solidification remedy for the remainder of the site would be difficult or impracticable to implement using cost effective and reliable construction techniques. This conclusion was confirmed independently by Kiber (see Appendix A of the TM-NDA).

This conclusion is consistent with expectations presented in Section 300.430(a)(iii)(B) of the National Contingency Plan (NCP), wherein USEPA expects engineering controls, such as containment, be implemented at sites where waste treatment is impracticable. In addition, and as presented in the preamble to the NCP, certain remedial alternatives are impracticable for specific sites due to severe implementability problems or prohibitive costs (55 FR 8704). At this location in the preamble, "*complete treatment of an entire large municipal landfill*," is referenced as an example of a site where treatment is considered impracticable or cost prohibitive. Although the Bailey Superfund Site is not a CERCLA municipal waste landfill, it has a number of attributes similar to a CERCLA municipal landfill, and it would be impracticable to treat the entire waste mass at the site due to implementability problems and prohibitive costs because of the volume, composition, heterogeneity, and organic content of the waste. In fact, many of the difficulties associated with treating an entire municipal landfill are also applicable to treating the waste at the Bailey Superfund Site (e.g., waste volume, composition, and heterogeneity; handling and sorting problems; high organic content; and presence of large items of debris). This conclusion is supported by the difficulties experienced during attempts to implement the original remedy.

Furthermore, the approach for evaluating the practicability of treating the waste at the Bailey Superfund Site is similar to the approach that would typically be used to evaluate the practicability of treating waste at a CERCLA municipal landfill. It is within this context that the document entitled "*Presumptive Remedy for CERCLA Municipal Landfill Sites*" [USEPA, 1993b] has applicability to the waste within the North Dike Area. In this document, USEPA considers treatment of MSW as infeasible and large scale removal as difficult to implement. In the document, USEPA established containment as a presumptive remedy for CERCLA municipal landfill sites. Since the waste in the North Dike Area has many similarities (with respect to remedy selection) to CERCLA municipal landfill wastes, the presumptive remedy of containment is considered applicable to the waste within this area.

Based on the additional data obtained during the supplemental site investigations, GeoSyntec concluded the following [GeoSyntec, 1995b]:

- solidification of the waste within the North Dike Area to specified performance criteria is technically infeasible and should be eliminated from further consideration;

- solidification of certain "hot spots" or localized areas of the North Dike Area may be appropriate if is it evaluated to be necessary as a component of the revised remedy; and

- if solidification is used as a component of a revised remedy for "hot spot" areas, the performance requirements should be evaluated and amended; new performance requirements should be developed that are both implementable and consistent with the engineering requirements of the revised remedy."

• 3.3 <u>East Dike Area</u>

A document entitled, "*Technical Memorandum, Supplemental East Dike Area and Pit B Site Investigations*," [GeoSyntec, 1996a] (TM-EDA/PB) presents the detailed information for the supplemental East Dike Area and Pit B site investigations. A copy of this document is included in Appendix B of this FFSR. The objectives, findings, and conclusions of the TM-EDA/PB regarding the East Dike Area are summarized below.

The East Dike Area supplemental site investigation was performed to better define the composition and nature of the waste in this area. Previous investigations and studies in the East Dike Area did not sufficiently characterize the waste (i.e., in terms of waste component types, particle size, heterogeneity, and presence of solidification inhibitors) for an evaluation of the technical feasibility of using in-situ solidification technologies.

The field work consisted of excavating seven test pits in the East Dike Area. The excavation of each test pit was carefully logged and documented to provide an estimation of the gross composition of the waste. Bulk waste samples were obtained at several depths from six of the test pits. The bulk waste samples were hand sorted and sieved to estimate the composition and particle size distribution of the smaller waste fractions. The laboratory program for this investigation involved testing selected waste samples for loss on ignition to estimate the percentage of organic material in the waste. Soil samples collected from beneath the waste were also tested to evaluate certain physical properties that will be used in the evaluation of alternative remedies for the Bailey Superfund Site, and for the development of an alternative design.

Based on the results of the field investigations and laboratory testing program, GeoSyntec concluded that a variety of municipal and industrial wastes were co-disposed in the northern portion of the East Dike Area (i.e., in the vicinity of test pits G-TP14, G-TP15, and G-TP16). These wastes include a high proportion of decomposed municipal solid waste, rubber crumb, and debris (metal, glass, and wood). The waste in the northern-middle portion of the East Dike Area (i.e., in the vicinity of test pits G-TP17, G-TP18, and G-TP19) is comprised of rubber crumb and other rubbery waste that also have a high organic content (loss on ignition up to 89.3 percent). This waste material was often observed as being a relatively hard mass that was more difficult to excavate than a typical uncemented soil material. In attempts to excavate this material, the track hoe tended to excavate sheet- or block-like pieces of the waste by tearing it from the hard waste mass. The southern-middle portion of the East Dike Area (i.e., in the vicinity of G-TP20 and the pilot demonstration performed by McLaren/Hart and Kiber) contains rubber crumb and rubbery waste that are not as hard as the northern-middle portion of the area. Locations of the different waste types within the East Dike Area are shown on Figure 1 of Appendix B. The waste within the southern portion of the East Dike Area was solidified as part of the original RA. It is also noted that the waste within the East Dike Area has a high organic content, as measured by loss of ignition.

As part of the supplemental East Dike Area site investigation, GeoSyntec evaluated the solidification component of the original remedy for the waste within this area using the logical framework used to evaluate the waste within the North Dike Area (see Section 3.2 of this FFSR). GeoSyntec concluded that successful in-situ solidification of the waste within the East Dike Area to the specified performance criteria is technically infeasible, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified.

In addition, according to the Record of Decision (ROD) for the Bailey Superfund Site, the functions of solidification are to "reduce the mobility of the wastes and provide strength to support the cap." Based on the results presented in the TM-EDA/PB, the wastes in the East Dike Area have adequate strength to support a final cover system and solidification for this purpose is not needed.

3.4 Summary

According to the ROD for the Bailey Superfund Site, the functions of solidification are to *"reduce the mobility of the wastes and provide strength to support a clay cap."* Based on the results presented in the technical memoranda for the North Dike Area and East Dike Area: (i) in-situ solidification of the waste in these areas to the specified performance criteria is technically infeasible, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified; and (ii) the wastes in these areas generally have adequate strength to support a final cover system, and solidification is not needed for this purpose.

The data and information obtained from the supplemental site investigations in the North Dike Area and East Dike Area were obtained for the evaluation of the original remedial design and the identification and evaluation of other potential remedial technologies and process options applicable to the wastes at the site. Therefore, upon completion of these investigations and the evaluation of the original remedial design, the remaining tasks associated with the FFS were commenced. The remainder of this document is the work product of these FFS tasks.

4. REMEDIAL ACTION OBJECTIVES

4.1 Overview

This section presents a summary of the potential human health and environmental impacts of the site based on the information included in the RI report. In addition, remedial action objectives for the site are addressed with respect to these human health and environmental impacts. Applicable or relevant and appropriate requirements (ARARs) for the site are provided in the detailed analysis of alternatives (Section 10 of this FFSR).

4.2 Exposure Pathways

The following potential exposure pathways were identified in the RI report.

- *"Direct contact with site media. This pathway includes dermal exposure and ingestion of water, soil, or sediments."*
- *"Surface water contamination from site runoff and episodic flooding, exchange of surface water between Pits A-1, A-2, A-3, the marsh, and Pond A. Pond A and the drainage ditch are also connected."*
- *"Surface water contamination from horizontal migration through the embankment of the Waste Channel (North Dike Area)."*
- *"Groundwater contamination from leaching of site contaminants. Potential exposure would be to drinking water and water used for washing and cooking."*
- *"Consumption of fish and other marine life exposed to surface water and sediment."*

4.3 Risk Assessment-Human Health Impacts

The RI report includes the results of the risk assessment for the site. A summary of the human health impacts identified in the RI report is provided below.

> *"Potential carcinogenic risks have been calculated for consumption of fish caught at the Bailey site, direct dermal and oral exposure, and through drinking water from wells located in residential areas.*
>
> *Drinking water exposure does not pose a current risk due to estimated arrival times in excess of 800 years. The potential maximum risk at the time is predicted to be 1.2×10^{-4} based on arsenic, benzene and trichloroethene. A value more representative of site findings is estimated to be 7.1×10^{-5} due to arsenic alone.*
>
> *Fish consumption risk assumed Bailey was the sole source of fish for life. The maximum risk was estimated at 1.7×10^{-3} based on arsenic, tetrachloroethane and bis(2-ethylhexyl)phthalate. A risk more representative of site biota analysis was calculated to be 7.0×10^{-8} based on the phthalate only (arsenic and tetrachloroethane were detected in only one sample of gar).*
>
> *Oral and dermal exposure on site was estimated to involve a maximum risk of 3.6×10^{-7} per exposure day for each route of exposure. Using median values for analytical results, this risk was reduced to 8.5×10^{-8} per exposure day based on arsenic and PAH.*
>
> *No attempt was made to combine exposure scenarios to give an integrated risk. Drinking water exposures are not concurrent with other exposure and should not be combined. Dermal and oral on-site exposure and fish consumption require construction of highly specific scenarios for which risks may be calculated using the referenced tables. For example, assuming 1 day exposure per week for 5 years, the maximum excess risk would be: $2 \times 3.6 \times 10^{-7}$/day x 1 day/week x 52 weeks/year x 5 years = 1.8×10^{-4}. Hazard Indices suggest a potential for systemic effects, particularly in children, resulting from on-site*

exposure. Hazard Indices for fish consumption now, or drinking water in the future are less than unity."

4.4 Risk Assessment-Environmental Impacts

A summary of the environmental impacts for the site was also included in the RI report and is provided below. References within the RI report citation are for the RI report and not the FFSR.

"Environmental exposure concentrations of indicator compounds were compared with available ARARs and background concentrations. Surface waste concentrations of metals were generally within aquatic-life criteria limits as shown in Table 9-10. Only one surface water sample taken from the marsh by Pit A-1 exceeded the criteria for copper. Neches River levels of copper also exceed the criteria (as discussed in Appendix R).

Volatile organics were not detected in surface waters. Heavier semi-volatile organics were detected in the open pits, Pond A and the marsh at up to 60 μg/L. The sample from Pit B contained over 30 mg/L. However, none of the site indicator chemicals, including PAH, were detected in surface waters. Modeling results indicate a time scale of 12.5 to 125 years for leaching from the Waste Channel (North Dike Area).

For sediments, Pit B is clearly different in character to other locations. Fiddler crabs in this area were observed to have black staining of their shells. Organics were detected at the highest concentration in Pit B sediments, but metals, particularly lead, copper, and arsenic were detected at higher levels in other sediments.

PAH compounds sorb strongly to soils and are expected to be relatively immobile (EPA 1979, Sims and Overcash, 1985). PAH levels in sediments may be elevated at the Bailey site based on comparison with Pond B sediment and Neches River measurements, but data are limited. Highest levels were in the *range of 2 to 4 ppm for individual PAH compounds. The PAH benzo(a)-pyrene was detected in the drainage channel sediment adjacent to the highway.*

Analysis of biota for metals and organics is discussed in Chapter 7.0 and Appendix P. Elevated levels of lead found in drainage channel sediment are not reflected in lead levels in biota. Lead levels in biota were less than locally measured in the Neches River and within the 85th percentile of a national survey. Copper was only found in crabs, but the range was comparable to background levels reported for the Neches River. Other metals, including zinc, were found at relatively elevated levels in only two samples, but no relation could be concluded with sediment levels.

Of the organics detected in biota, phthalates are widely distributed in the environment and the levels detected were consistent with background levels reported in Neches River biota. Nitrosamines such as n-nitrosodi-phenylamine and other tentatively identified compounds are also of uncertain origin and are derived from natural and synthetic sources. The former compound was indicated to be present in the waste at up to 690 ppm but definite identification or quantification was not obtained. The significance of tentatively identified and unknown compounds is addressed in Appendix R, but there are insufficient data to draw conclusions relating such compounds specifically to the Bailey site or to potential biological impacts.

A comprehensive audit of area ecology was not undertaken. Health of organisms other than the very limited sample of aquatic specimens captured was not assessed. Fish and crabs caught on site appeared, from visual examination, to be healthy. Fiddler crabs in the vicinity of Pit B appeared to have black staining on their shells.

A chlorinated paraffin was tentatively identified in one of the gar but the specific compound (tetrachloroethane) was not detected in any other soil, waste, sediment or water samples. Arsenic was also detected in this fish but in no other samples of biota. Zinc was also highest of the gar samples, and second only to a solitary catfish containing 143 mg/kg. From limited comparisons of crab and fish tissue with local and national background levels *of metal, remaining biota samples did not appear to contain higher than background levels of the indicator metals. Abundant bird species, alligators, snakes, nutria, and muskrat were sighted during the course of the RI investigation.*"

4.5 Remedial Action Objectives

Based on a review of the potential human health and environmental impacts, the remedial alternative recommended in this FFSR for the Bailey Superfund Site will be consistent with the NCP and other USEPA guidance documents and will accomplish the following remedial action objectives:

- protection of the human health and the environment during implementation of the remedial alternative;
- long-term, effective control of migration of site constituents through ground-water, surface-water, soil, and air pathways; and
- long-term, effective reduction of current and potential future risk to human health and the environment resulting from migration of site constituents through ground-water, surface-water, soil, and air pathways.

5. GENERAL RESPONSE ACTIONS

5.1 Overview

According to the document entitled *"Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"* [USEPA, 1988b], general response actions describe *"those actions that will satisfy the remedial action objectives."* Based on an evaluation of the remedial action objectives identified in Section 4 of this FFSR and a review of available general response actions, the following general response actions were selected for evaluation at the Bailey Superfund Site:

- containment;
- in-situ treatment; and
- removal/ex-situ treatment (if necessary)/disposal.

These general response actions are described below.

5.2 Containment

Containment of the waste would include the construction of one or both of the following:

- a cap installed above the waste to prevent human and wildlife contact with the waste and limit precipitation infiltration into the waste, thereby reducing the contaminant mass that could potentially leach out of the waste; and
- a vertical subsurface barrier installed around the perimeter of the waste to limit ground-water flow into and out of the waste, thus reducing the contaminant mass that could potentially leach out of the waste.

5.3 In-Situ Treatment

In-situ treatment of the waste would decrease the mobility, toxicity, and/or volume of the waste without having to excavate the waste. Physical process options generally prevent or limit the movement of waste constituents. In contrast, chemical process options may, under some circumstances, be effective in reducing the toxicity or volume of waste constituents.

5.4 Removal/Ex-Situ Treatment/Disposal

This general response action includes three separate components. First, the waste materials at the site would be excavated (removed) using commonly available mechanical equipment (i.e., backhoes, bulldozers). Second, and only as necessary, the waste would be physically or chemically treated to meet handling or disposal requirements. This step could also include dewatering of the excavated materials to improve its handling characteristics. Finally, the waste (either treated or untreated) would be disposed in an appropriately-permitted landfill.

6. IDENTIFICATION AND PRELIMINARY SCREENING OF PROCESS OPTIONS

6.1 Overview

This section presents the identification and preliminary screening of process options with respect to the remedial response actions identified in Section 5 of this FFSR. The preliminary screening process for this FFS is consistent with procedures included in the following USEPA documents: *"Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA"* [USEPA, 1988b], and *"Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA"* [USEPA, 1993a].

6.2 Identification and Preliminary Screening

In accordance with nomenclature used in USEPA guidance documents, the following terminology is used within this FFSR:

- "remedial technologies" refers to general treatment categories, such as chemical treatment, capping, or thermal treatment; and

- "process options" refers to specific treatment processes within each remedial technology; for example, the chemical treatment technology might include the following process options: precipitation, ion exchange, and oxidation/reduction; several process options may exist for each remedial technology.

The remedial technologies and process options included in this FFSR were selected from those considered in the FS and proposed in the Work Plan. Remedial technologies and process options included in *"Technology Screening Guide for Treatment of CERCLA Soils and Sludges"* [USEPA, 1988c] were reviewed during the preparation of the Work Plan to identify other remedial technologies or process options potentially applicable to the Bailey Superfund Site.

The criteria used for the preliminary screening of the process options were:

- applicability - the process option is appropriate for the type(s) of contamination or waste present at the Bailey Superfund Site; and
- technical implementability - the process option can be constructed and reliably operated, and can meet the remedial action objectives during and after implementation; also, the components of the process option can be operated, maintained, replaced, and monitored, as necessary, after the remedial action is completed.

The process options included in the preliminary screening are listed below.

Remedial Technology	**Process Option**
Capping	Single component cap Lightweight composite cap Consolidation water absorption layer Consolidation water collection system
Vertical subsurface barriers	Slurry walls Jet grouted walls Vibrating beam walls Sheet pile walls Polymeric membrane walls
In-situ physical treatment	Solidification Vitrification
In-situ chemical treatment	Soil flushing Chemical fixation Biodegradation
Ex-situ physical treatment	Solidification
Ex-situ chemical treatment	Chemical fixation/reduction Soil washing/solvent extraction

Remedial Technology	Process Option
Ex-situ solids dewatering	Belt press Filter press Sludge drying beds
On-site disposal	Mechanical excavation and disposal in a RCRA Subtitle C equivalent[1] landfill constructed on site
Off-site disposal	Mechanical excavation and disposal in a non-hazardous (RCRA Subtitle D) or equivalent[1] landfill Mechanical excavation and disposal in a hazardous (RCRA Subtitle C) or equivalent[1] landfill
[1] The term "equivalent" includes landfills permitted under appropriate state regulations	

Descriptions of these remedial technologies and process options and results of the preliminary screening are presented in Table 6-1.

Certain process options eliminated in the FS were similarly rejected and therefore eliminated from further consideration in this document. Reasons for rejecting these items include: (i) no improvements in the individual process options have occurred since the time of the FS (1988) to increase their applicability to, or technical implementability at, the Bailey Superfund Site; (ii) no additional data or information have been obtained to change their applicability to, or technical implementability at, the Bailey Superfund Site; and (iii) the reasons for their rejection during the screening in the FS have not changed (i.e., technically infeasible or not applicable for the conditions at the Bailey Superfund Site).

6.3 Summary of Preliminary Screening of Process Options

6.3.1 Introduction

The process options retained following the preliminary screening are presented below. These process options will be further evaluated in a secondary screening process in Section 7 of this document.

The process options selected for the original remedial design were retained during the FFS preliminary screening to provide a baseline for comparison. These process options are: (i) in-situ solidification of the waste with specified performance criteria for unconfined compressive strength and hydraulic conductivity of the solidified waste; and (ii) a single component cap.

6.3.2 Capping

The following capping process options were retained following the preliminary screening.

- *Single component cap.* This cap was part of the original remedial design and includes a 2.5-ft (0.76-m) thick layer of compacted clay overlain by a 0.5-ft (0.15-m) thick topsoil layer; this cap was retained for comparison purposes.

- *Lightweight composite cap.* A geosynthetic/soil cap would be designed to generally meet the substantive guidance of USEPA for a RCRA Subtitle C facility [USEPA, 1991], with modification as appropriate to satisfy site-specific design criteria or constraints, including criteria to satisfy the "lightweight" criterion. Potential cap components include (from bottom to top) a geosynthetic clay liner (GCL), geomembrane, geocomposite drainage layer, protective cover soil layer, and vegetation layer.

- *Consolidation water absorption layer.* An absorption layer would be placed immediately beneath a cap to provide storage volume for liquids that may be squeezed from the waste due to waste consolidation under the weight of the cap (hereafter referred to as consolidation water). This layer would be included in the design of a cap, if necessary, to enhance the performance of the cap.

- *Consolidation water collection system.* A system would be placed beneath the cap to provide the ability to collect and remove consolidation water from the waste. This process option would be included in the design of the cap, if necessary, to enhance the performance of the cap.

6.3.3 Vertical Subsurface Barriers

A vertical subsurface barrier would be installed around all, or a portion of the waste areas to limit ground-water flow into and out of the waste, if necessary. Process options for vertical subsurface barriers include: slurry walls, jet grouted walls, vibrating beam walls, sheet pile walls, and polymeric membrane walls.

When used with an appropriately designed cap, a vertical subsurface barrier would enhance the overall performance of the containment remedy in comparison to the performance of a remedy incorporating only a cap. Therefore, the need for a vertical subsurface barrier will be based on the results of the analysis of technical equivalency, which is presented as Section 8 of this FFSR.

6.3.4 In-Situ Treatment

In-situ waste treatment process options retained during the preliminary screening include:

- *In-situ solidification - original remedial design.* This process option involves waste solidification to meet performance criteria for unconfined compressive strength and hydraulic conductivity.

- *In-situ solidification - alternate performance criteria.* With this process option, the waste would be solidified to meet alternate performance criteria. These alternate performance criteria would most likely only include a criterion for unconfined compressive strength (no hydraulic conductivity criterion).

- *In-situ solidification - method-based specification.* For this process option, the waste would be solidified to meet a method-based specification. The method-based specification would describe the construction method, solidification admixture, and rate of admixture application to be used to solidify the waste and would not include unconfined compressive strength or hydraulic conductivity criteria for the solidified waste.

6.3.5 Removal/Ex-Situ Treatment/Disposal

These process options would include the mechanical excavation of the waste and disposal in a hazardous waste (RCRA Subtitle C) or equivalent landfill. Ex-situ solidification of the waste would be performed to improve handling properties, if necessary.

TABLE 6-1
PRELIMINARY SCREENING OF PROCESS OPTIONS
BAILEY SUPERFUND SITE, ORANGE COUNTY, TEXAS

Gen. Response Actions	Remedial Technologies	Process Options	Description	Evaluation Comments
Containment	Capping	Single Component Cap	Cap in original design (2.5-ft (0.76-m)-thick clay layer with 0.5-ft. (0.15-m)-thick topsoil layer). Single component cap is used to limit infiltration, control erosion, and manage surface drainage.	Retained for additional screening and for comparison with lightweight composite cap.
		Lightweight Composite Cap	Lightweight geosynthetic cap that meets the substantive recommendations of USEPA for a RCRA[1] Subtitle C landfill that would consist of the following layers (from top to bottom): vegetation, topsoil, geocomposite drainage layer, a geomembrane, a geosynthetic clay liner (GCL), and graded fill.	Retained for screening.
		Consolidation Water Absorption Layer	Consolidation water absorption layer to provide storage space (pores) for liquids resulting from consolidation of waste (for use with capping, if necessary).	Retained for screening.
		Consolidation Water Collection System	Consolidation water collection system to collect and remove liquids resulting from consolidation of the waste (for use with capping, if necessary).	Retained for screening.

TABLE 6-1 (continued)

Gen. Response Actions	Remedial Technologies	Process Options	Description	Evaluation Comments
Containment (continued)	Vertical Subsurface Barriers (for use with capping if necessary, following analysis of technical equivalency of the potential remedial alternative to the original remedial design)	Slurry Walls	Trenches surrounding area of contamination are filled with a soil-bentonite or cement-bentonite slurry.	Retained for screening.
		Jet Grouted Walls	High pressure injection of grout to depth of contamination in closely-spaced boreholes around perimeter of waste.	Retained for screening.
		Vibrating Beam Walls	Vibrating force used to advance steel beam vertically to depth. Slurry mixture is injected as the beam is withdrawn to create continuous barrier.	Retained for screening.
		Sheet Pile Walls	Interlocking steel or vinyl sheet piling driven to depth around the area of contamination.	Retained for screening.
		Polymeric Membrane Walls	Synthetic liners or membranes installed vertically in a trench or by using a vibrating force.	Retained for screening.
In-Situ Treatment	Physical Treatment	Solidification	Original remedial design component. Contaminated media mixed with pozzolanic/cement or ash materials to solidify and reduce mobility of contaminants and increase strength of waste materials to support capping.	Retained as baseline for screening.
		Vitrification	Electric melting of contaminated solids to destroy/remove organics and to immobilize/remove inorganics. The organics are destroyed by thermal decomposition and the inorganics are incorporated in the glass and microcrystalline residual product. Off-gases are collected and treated.	Rejected - eliminated in FS preliminary screening.

TABLE 6-1 (continued)

Gen. Response Actions	Remedial Technologies	Process Options	Description	Evaluation Comments
In-Situ Treatment (continued)	Chemical Treatment	Soil Flushing	A solvent or surfactant solution is injected into the contaminated area to increase contaminant solubility and mobility. The contaminated solution is then collected in a production well and treated.	Rejected - eliminated in FS preliminary screening.
		Chemical Fixation	Chemical reagents are injected into the contaminated area and react with the desired constituents to form a less soluble or hazardous compound. This process can be enhanced by providing a means of mixing the soils with the reagents (the more thorough the mixing, the better the reaction).	Rejected - eliminated in FS preliminary screening.
		Biodegradation	In-situ treatment for oily sludges and some organic wastes using micro-organisms to breakdown organic compounds.	Rejected - eliminated in FS preliminary screening.
Removal/Ex-Situ Treatment/Disposal	On-Site Disposal	Mechanical Excavation and Disposal in a Hazardous Waste (RCRA Subtitle C "equivalent") Landfill Constructed On-Site	Use of mechanical excavation equipment to remove wastes and place in an on-site disposal cell(s). Permanent storage facility constructed on site, double-lined with clay and a synthetic membrane liner and containing a leachate collection/detection system.	Rejected - not implementable on site.
	Off-Site Disposal	Mechanical Excavation and Disposal in a Non-Hazardous Waste (RCRA Subtitle D) or equivalent[1] Landfill	Use of mechanical excavation equipment to remove wastes for off-site disposal at a non-hazardous waste (RCRA Subtitle D) or equivalent[2] landfill.	Rejected - eliminated in FS preliminary screening.
		Mechanical Excavation and Disposal in a Hazardous Waste (RCRA Subtitle C) or equivalent[1] Landfill	Use of mechanical excavation equipment to remove wastes for off-site disposal at a hazardous waste (RCRA Subtitle C) or equivalent[2] landfill	Retained for screening.

TABLE 6-1 (continued)

Gen. Response Actions	Remedial Technologies	Process Options	Description	Evaluation Comments
Removal/Ex-Situ Treatment/Disposal (continued)	Physical Treatment	Solidification	Contaminated media mixed with pozzolanic/cementor ash materials which can solidify and reduce mobility of contaminants. To be used in conjunction with off-site disposal, if necessary.	Retained for screening. Will be combined with Mechanic Excavation and RCRA Subtitle C Landfill, if necessary.
	Solids Dewatering	Belt Press	Waste is passed on a continuous belt through a series of rollers. A second belt moving at the same speed as the first belt is pressed against the waste by the rollers. Water passes through the belt and is collected. The solids, retained on the belt, are removed by a blade and dropped into a hopper for disposal/furthertreatment.	Rejected - eliminated in FS preliminary screening.
		Filter Press (plate and frame)	Waste is dewatered by passing it through a press under pressure. The press consists of a series of perforated plates covered with filter cloth. The waste is fed into the center of each plate. The solids are retained on the filter cloth surface while the water passes through and is collected. The sludge cake is removed from the cloth and collected in a hopper for disposal/furthertreatment.	Rejected - eliminated in FS preliminary screening.
		Sludge Drying Beds	Waste is placed onto sand drying beds to allow evaporation and drainage of excess moisture.	Rejected - eliminated in FS preliminary screening.

TABLE 6-1 (continued)

Gen. Response Actions	Remedial Technologies	Process Options	Description	Evaluation Comments
Removal/Ex-Situ Treatment/Disposal (continued)	Chemical Treatment	Chemical Fixation/ Reduction	Chemical reagents are mixed with the waste in a pugmill or similar mixer and react with the desired constituent to form a less toxic compound or to immobilize the contaminant by converting it to a less soluble, more stable form.	Rejected - eliminated in FS preliminary screening.
		Soil Washing/Solvent Extraction	The waste and chemical reagents are mechanically mixed to react and form soluble complexes. The desired constituent is mobilized and removed in solution. Further processing of the solution is required to remove the desired constituent.	Rejected - eliminated in FS preliminary screening.

[1] RCRA - Resource Conservation and Recovery Act
[2] The term equivalent includes landfills permitted under appropriate state requirements.

7. SECONDARY SCREENING OF PROCESS OPTIONS

7.1 Overview

This section presents the secondary screening of process options retained following the preliminary screening. The criteria and rating system used for the secondary screening of process options and the results of the secondary screening are discussed below. Process options retained following this secondary screening will be analyzed for technical equivalency and assembled into remedial alternatives in Sections 8 and 9 of this FFSR, respectively. The remedial alternatives will be further evaluated in Section 10 of this FFSR.

7.2 Screening Criteria

The process options retained in Section 6 of this document for further consideration were screened using criteria established in the "*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*" [USEPA, 1988b] and "*Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*" [USEPA, 1993a]. These criteria are:

- *Effectiveness*. Effectiveness is evaluated based on the ability of the process option to meet the remedial action objectives. Both short-term and long-term effectiveness are evaluated within this criterion. Short-term effectiveness considers the length of time required to implement the process option and any adverse effects on human health or the environment during the construction or implementation period. Long-term effectiveness considers the ability of the process option to limit contaminant migration following the construction period and includes a relative assessment of the reduction in contaminant toxicity, mobility, or volume provided by the process option.

- *Implementability*. This criterion evaluates both the technical and administrative implementability of the process option. Technical implementability considers the ability to construct and reliably operate and maintain the process option and to monitor the process option after implementation. Administrative implementability considers: (i) the ability to obtain necessary regulatory approvals; (ii) the type and availability of necessary treatment, storage, and disposal services; and (iii) the availability of necessary equipment and technical expertise.

- *Cost.* This criterion evaluates the capital, operations, and maintenance costs of the process option. This criterion is used to identify whether the cost of the process option is grossly disproportionate to other process options when compared to the level of effectiveness achieved. In accordance with USEPA guidance, detailed cost estimates are not prepared at this stage of the screening process. Rather, the process option is evaluated based on experience and judgment and in terms of cost versus effectiveness.

7.3 Rating System

For the secondary screening process, a five-point rating system was utilized to score the process options for each criterion. This system uses a range of scores from 1 to 5, with 1 being the lowest (worst) rating and 5 as the highest (best) rating.

The total rating score for each process option represents the sum of the five evaluation criterion scores: short-term effectiveness, long-term effectiveness, technical implementability, administrative implementability, and cost. The decision to reject or retain a particular process option was made on the basis of the total rating score relative to the total rating scores for other process options. In addition, a ranking of 1 in any of the five evaluation criteria was deemed sufficient justification to reject that process option from further consideration.

7.4 Secondary Screening of Process Options

7.4.1 Introduction

This section presents the results of the secondary screening of each process option. The process options retained from the preliminary screening were screened using the criteria and the five-point ranking system presented above. Table 7-1 presents a numerical summary of the secondary screening results.

7.4.2 Capping

7.4.2.1 Single Component Cap

Description of Process Option

This process option represents the cap configuration included in the original remedial design prepared by HLA. From bottom to top, the cap would consist of the following: (i) graded general fill (up to 2.0 ft (0.6 m) thick) to provide a slight slope to the cap for stormwater control; (ii) a 2.5-ft (0.76-m) thick layer of compacted clay to limit infiltration; and (iii) a 0.5-ft (0.15-m) thick topsoil layer to support vegetation and protect the cover. The clay layer would be compacted to a hydraulic conductivity of not more than 1×10^{-7} cm/s. The configuration of the single component cap is shown in Figure 7-1.

Functions

The functions of the single component cap are:

- prevent direct contact by humans and wildlife with the wastes and affected soils;
- limit direct contact by precipitation with the wastes and affected soils;
- promote stormwater runoff and route the runoff to prevent contact with waste;
- control the generation of leachable liquids from the waste; and
- control the migration of site constituents through ground-water, surface-water, soil, and air pathways.

Effectiveness

Short term. The construction of the cap and related appurtenances would result in the need for the following measures to limit human exposure and adverse environmental impacts: (i) dust suppression; (ii) equipment and personnel decontamination facilities; (iii) use of personnel protection equipment; and (iv) stormwater control.

Long term. The single component cap would provide long-term effectiveness by preventing direct contact with the waste by humans, wildlife, and stormwater runoff. The low hydraulic conductivity of the compacted clay layer would limit infiltration by precipitation, thus reducing possible future impacts to ground water. However, the weight of this capping system (due to the amount of soil required to construct the cap) would cause consolidation of the waste and settlement of the cap. This process would squeeze consolidation water out of the waste and into the surrounding soil formation. This process may result in an adverse impact on ground water.

The cap would be graded to promote stormwater runoff, thus reducing the amount of water available for infiltration. The cap would need to be maintained to prevent desiccation and/or settlement cracking, penetration by plant roots, or erosion which would decrease the integrity of the compacted clay. Based on the relative thinness (6 in. (150 mm)) of the topsoil layer above the compacted clay, the climate at the site, and lack of a geomembrane over the compacted clay, it is likely that the hydraulic conductivity of the compacted clay will progressively increase from its "as constructed" value to a larger value due to desiccation (this topic is discussed in more detail in Section 8 of this FFSR). The cap would reduce contaminant mobility by isolating the waste, but would have no effect on contaminant toxicity or volume.

Effectiveness Rating. Based on consideration of the factors presented above, this process option received the following effectiveness ratings:

- Short-Term Effectiveness Rating: 3; and
- Long-Term Effectiveness Rating: 3.

Implementability

Technical. The single component cap would require the placement, grading, and compaction of relatively large volumes of general fill material. No attempt was made to construct this type of cover system at the Bailey Superfund Site during the previous RA due primarily to the problems associated with the solidification component of the original remedial design. Construction of the single component cap could be performed with locally available construction equipment. A large volume of fill material would have to be transported to the site, therefore the roads within the vicinity of the site would have a significant amount of heavy construction traffic. The technical expertise necessary to design the single component cap is readily available.

The use of a cap at the Bailey Superfund Site is consistent with expectations presented in Section 300.430(a)(iii)(B) of the National Contingency Plan (NCP), wherein USEPA expects engineering controls, such as containment, be implemented at sites where waste treatment is impracticable. In addition, and as presented in the preamble to the NCP, certain remedial alternatives are impracticable for specific sites due to severe implementability problems or prohibitive costs (55 FR 8704). At this location in the preamble, "*complete treatment of an entire large municipal landfill*," is referenced as an example of a site where treatment is considered impracticable or cost prohibitive. Although the Bailey Superfund Site is not a CERCLA municipal waste landfill, it has a number of attributes similar to a CERCLA municipal landfill, and it would be impracticable to treat the entire waste mass at the site due to implementability problems and prohibitive costs because of the volume, composition, heterogeneity, and organic content of the waste. In fact, many of the difficulties associated with treating an entire municipal landfill are also applicable to treating the waste at the Bailey Superfund Site (e.g., waste volume, composition, and heterogeneity; handling and sorting problems; high organic content; and presence of large items of debris). This conclusion is supported by the difficulties experienced during attempts to implement the original remedy.

Furthermore, the approach for evaluating the practicability of treating the waste at the Bailey Superfund Site is similar to the approach that would typically be used to evaluate the practicability of treating waste at a CERCLA municipal landfill. It is within this context that the document entitled "*Presumptive Remedy for CERCLA*

Municipal Landfill Sites" [USEPA, 1993b] has applicability to the waste at the Bailey Superfund Site. In this document, USEPA considers treatment of MSW as infeasible and large scale removal as difficult to implement. In the document, USEPA established containment as a presumptive remedy for CERCLA municipal landfill sites. Since the waste at the Bailey Superfund Site has many similarities (with respect to remedy selection) to CERCLA municipal landfill wastes, the presumptive remedy of containment is considered applicable to the waste at the site.

Administrative. The original remedial design for the Bailey Superfund Site includes the installation of a single component cap following in-situ solidification of the waste. Therefore, USEPA has already approved the installation of the single component cap following the in-situ solidification activities. However, if the revised remedy for the site includes a single component cap without the in-situ solidification of the waste, USEPA would need to take administrative action to modify or change the ROD.

The design of the cap would need to include a stormwater management plan to control site drainage and erosion. A long-term maintenance program that includes inspections, mowing, seeding, and general maintenance of the cap and stormwater control features would be required.

Implementability Rating. Based on consideration of the factors presented above, this process option received the following implementability ratings:

- Technical Implementability Rating: 2; and
- Administrative Implementability Rating: 3.

Cost

Materials for the construction of a single component cap are most likely available within a reasonable distance from the site and at a reasonable cost. The cost of the single component cap (excluding the cost of subgrade strength improvements) is reasonable considering the level of effectiveness achieved.

Based on consideration of the factors presented above, this process option received a cost rating as follows:

- Cost Rating: 3.

Screening Summary

The single component cap received a total score of 14, and is rejected from further consideration. This rejection is consistent with the original remedial design which requires this process option to be combined with in-situ solidification to achieve an acceptable level of protection to human health and the environment.

7.4.2.2 Lightweight Composite Cap

Description of Process Option

The lightweight cap would be designed and constructed to generally meet the substantive guidance of USEPA for a RCRA Subtitle C cap [USEPA, 1991], with modification as appropriate to satisfy site-specific design criteria and constraints, including criteria to satisfy the "lightweight" criterion. The cap would include a relatively thin (up to 2.0 ft (0.6 m) thick) general fill layer over the existing ground surface to provide a uniform surface for the geosynthetic materials and to provide a slight slope to promote stormwater runoff. The thickness of the fill would vary depending on the existing ground surface topography. A geogrid reinforcement layer would be placed within the fill layer, if needed, depending on the bearing capacity characteristics of the cap foundation. A GCL would be placed over the fill to provide a low hydraulic conductivity layer (maximum hydraulic conductivity of about 1×10^{-9} cm/s). A geomembrane would overlie the GCL to protect the GCL and provide an essentially impermeable composite cap. A geocomposite drainage layer would be installed over the geomembrane to provide a lateral drainage layer with a relatively high hydraulic transmissivity. The geocomposite drainage layer would prevent the buildup of any significant hydraulic head on the composite cap and thereby limit the potential for infiltration through the cap. A protective soil layer would be placed above the geocomposite. This cover soil, and the vegetation layer it supports, would protect the geosynthetic layers from ultra-violet radiation and temperature extremes. The vegetation layer would limit erosion of the cover soil. The thicknesses of these layers would be limited to the extent possible to satisfy the "lightweight" criterion, while maintaining the ability to support vegetation. On a preliminary basis, the required thickness of the protective layer is estimated to be 0.75 to 1.0 ft. (0.23 to 0.30 m). The configuration of the lightweight composite cap is shown in Figure 7-2.

Function

The functions of a lightweight composite cap are:

- prevent direct contact by humans and wildlife with the wastes and affected soils;
- limit direct contact by precipitation with the wastes and affected soils;
- promote stormwater runoff and route the runoff to prevent contact with waste;
- control the generation of leachable liquids from the waste; and
- control the migration of site constituents through ground-water, stormwater, soil, and air pathways.

Effectiveness

Short term. The construction of the cap and related appurtenances would result in the need for the following measures to limit human exposure and adverse environmental impacts: (i) dust suppression; (ii) equipment and personnel decontamination facilities; (iii) use of personnel protection equipment; and (iv) stormwater control.

Long term. The lightweight composite cap would provide long-term effectiveness by preventing direct contact with the waste by humans, wildlife, and stormwater runoff. The composite cap would virtually eliminate the infiltration of precipitation into the waste and affected soils, thus reducing potential long-term ground-water impacts. In addition, since the lightweight cap would weigh less than the single component cap, less consolidation of the waste would occur in comparison to a single component cap constructed over unsolidified waste. Therefore, a reduced quantity of liquids would be squeezed from the waste and into the surrounding soil formation.

The lightweight composite cap would allow less infiltration than the single component cap. The cap would need to be maintained in a similar manner as the single component cap, but would require less maintenance since desiccation of the clay layer would not occur, and settlement of the cap would be reduced due to the lower imposed load when compared to the single component cap constructed over unsolidified waste. The lightweight composite cap would isolate the waste (reducing contaminant mobility) but would not reduce contaminant toxicity or volume.

Effectiveness Rating. Based on consideration of the factors presented above, this process option received the following effectiveness ratings:

- Short-Term Effectiveness Rating: 4; and
- Long-Term Effectiveness Rating: 4.

Implementability

Technical. The geosynthetic materials that would be included in the lightweight composite cap are readily available. Of particulate note for the Bailey Superfund Site, certain geosynthetic materials may already be available on site as a result of their previous procurement by Chem Waste. In addition, the technical and construction expertise needed to implement this process option are readily available. Construction of the cap would require less time than construction of the single component cap since less soil would need to be transported to the site, placed, compacted, and tested.

Since the waste at the Bailey Superfund Site has many similarities (with respect to remedy selection) to CERCLA municipal landfill wastes, the presumptive remedy of containment is considered applicable to the waste at the site (as presented in Section 7.4.2.1 of this FFSR).

Administrative. If the revised remedy for the site includes a lightweight composite cap without the in-situ solidification of the waste, USEPA would need to take administrative action to modify or change the ROD. However, since the composite cap would be designed to generally meet the substantive guidance of USEPA for a RCRA Subtitle C facility, administrative implementation of this process option should be feasible.

Implementability Rating. Based on consideration of the factors presented above, this process option received the following implementability ratings:

- Technical Implementability Rating: 5; and
- Administrative Implementability Rating: 5.

Cost

The cost to construct a lightweight composite cap could be greater than the cost to construct the single component cap. However, the effectiveness of the lightweight composite cap is significantly greater than the single component cap since infiltration through the lightweight cap would be less and the lightweight cap would cause less consolidation of the waste and less consolidation water. Therefore, the cost is considered low considering the high level of effectiveness achieved. In addition, cost savings may be realized through the use of previously procured geosynthetic materials currently available on site.

Based on consideration of the factors presented above, this process option received a cost rating as follows:

- Cost Rating: 3.

Screening Summary

The total rating score for the lightweight composite cap is 21. This process option is retained for further consideration.

7.4.2.3 Consolidation Water Absorption Layer

Description of Process Option

The consolidation water absorption layer is considered a potential enhancement to either the single component cap or the lightweight composite cap. This layer would consist of a porous, relatively-incompressible material (potential materials include: fly ash, broken shells, sand or gravel). The absorptive material would be placed over the waste to a thickness of approximately 1 to 2 ft (0.3 to 0.6 m). The cap would be installed on top of the consolidation water absorption layer. Depending on the type of material used for the layer, it could take the place of the general fill.

Function

The consolidation water absorption layer would be designed to have a high void space sufficient for the containment of the consolidation water. The consolidation water would therefore be contained within the area of disposed wastes rather than being forced into the surrounding soil formation.

Effectiveness

<u>Short term.</u> Minimal excavation or disturbance of waste would be required to place the consolidation water absorption layer, thus limiting contaminant exposure potential. The time required to place the layer would be approximately the same as the time required to place the general fill that would be required for a cap.

<u>Long term.</u> The consolidation water absorption layer would reduce the mobility of the contaminants present in the liquid portion of the waste by retaining them within the capped area; however, it would not reduce the volume or toxicity of the waste.

<u>Effectiveness Rating.</u> Based on consideration of the factors presented above, this process option received the following effectiveness ratings:

- Short-Term Effectiveness Rating: 4; and
- Long-Term Effectiveness Rating: 3.

Implementability

Technical. The consolidation water absorption layer would require a significant amount of material to be transported to the site, thus increasing the amount of traffic near and around the site. However, the increase in traffic would be no more than the amount of traffic to transport the general fill that will be required for a cap (as previously noted, the consolidation water absorption layer may replace the general fill). The local availability of porous material needed for this layer is considered questionable. The material could be placed with widely available construction equipment.

Administrative. The consolidation water absorption layer would be installed in conjunction with an overlying cap, therefore regulatory approval of the layer is considered good since the original remedial design included a cap. Although the design and construction of a consolidation water absorption layer is not routinely performed, the expertise is readily available. Since the waste would not be disturbed by the placement of the layer, treatment, storage, and disposal of waste or waste affected materials would not be required.

Implementability Rating. Based on consideration of the factors presented above, this process option received the following implementability ratings:

- Technical Implementability Rating: 2; and
- Administrative Implementability Rating: 4.

Cost

The incremental cost to construct the consolidation water absorption layer is considered low if locally available material can be used, especially if this layer is used in place of general fill that would be required prior to placing a cap. The cost would be higher if suitable material is not readily available.

Based on the understanding that suitable absorption materials may not be locally available this process option received a cost rating as follows:

- Cost Rating: 2.

Screening Summary

The consolidation water absorption layer has a total rating score of 15 and is therefore rejected as a potential enhancement to a capping remedy.

7.4.2.4 Consolidation Water Collection System

Description of Process Option

The consolidation water collection system is considered a potential enhancement to either the single component cap or the lightweight composite cap. This system would be installed before the placement of the general fill layer and consist of a series of perforated pipes placed in the bottoms of gravel-filled collection trenches. The perforated pipes, which would be installed at or slightly above the ground-water table, would convey consolidation water to collection sumps. This water would then be pumped to the existing wastewater holding tank, treated to the current discharge limits, if necessary, and discharged. After placement of the general fill layer and prior to the placement of the remaining cap components, the sumps would be removed and backfilled with general fill.

Function

The consolidation water collection system would be designed to have a flow capacity sufficient for the collection and removal of the consolidation water. The consolidation water would therefore be removed from the waste areas rather than being left in place with the potential for at least some of the water to be squeezed into the surrounding subsurface soils.

Effectiveness

Short term. Minimal excavation or disturbance of waste would be required to place the collection trenches, thus limiting contaminant exposure potential. The time required to install the consolidation water collection system would be less that the time required to place the consolidation water absorption layer.

Long term. The consolidation water collection system would reduce the mobility of the contaminants present in the liquid portion of the waste by removing the consolidation water from the areas of disposed wastes; however, it would not reduce the volume or toxicity of the waste.

Effectiveness Rating. Based on consideration of the factors presented above, this process option received the following effectiveness ratings:

- Short-Term Effectiveness Rating: 4; and
- Long-Term Effectiveness Rating: 4.

Implementability

Technical. The consolidation water collection system would require a relatively small quantity of material to be transported to the site, thus slightly increasing the amount of traffic near and around the site. The increase in traffic would be less than the amount of traffic needed to transport the materials for the consolidation water absorption layer. Local availability of materials needed for this system is considered good. The system could be installed with widely available construction equipment. Also, the wastewater treatment system that is presently on site would be used for the treatment of collected liquids.

Administrative. Construction of the consolidation collection system would be incorporated into other construction activities associated with the construction of a capping system; therefore, regulatory approval of the system is considered good. Construction could involve a minimal amount of waste disturbance. However, excavated materials would be consolidated into the other areas of the site that will be capped. Therefore, no treatment, storage, and disposal of waste or waste affected materials would be required (with the exception of the consolidation water). Since the system would utilize the existing wastewater treatment system (that is presently being used for management of stormwater), no administrative actions would be required with respect to the treatment and discharge of water, provided that the existing water discharge criteria can be obtained.

Implementability Rating. Based on consideration of the factors presented above, this process option received the following implementability ratings:

- Technical Implementability Rating: 4; and
- Administrative Implementability Rating: 4.

Cost

The incremental cost to construct the consolidation water collection system is considered low since a relatively small quantity of locally available material will be needed to construct the system. This process option therefore received a cost rating as follows:

- Cost Rating: 3.

Screening Summary

The consolidation water collection system has a total rating score of 19 and will be retained as a potential enhancement to a capping remedy.

7.4.3 Vertical Subsurface Barriers

7.4.3.1 Introduction

General Description of Process Options

A vertical subsurface barrier is considered a potential enhancement to a capping remedy, especially in areas where sludge-like wastes are present. The need for a vertical subsurface barrier is evaluated as part of the analysis of technical equivalency, as presented in Section 8 of this document.

The following vertical subsurface barrier process options were retained following the preliminary screening:

- slurry walls;
- jet grouted walls;
- vibrating beam walls;
- sheet pile walls; and
- polymeric membrane walls.

The above process options consist of subsurface structures designed to reduce the lateral migration of liquids and/or contaminants from a source in comparison to the potential for migration in the absence of the structures.

Since no barrier system can provide absolute containment of constituents for an indefinite time period, the selection of the vertical subsurface barrier type is largely dependent upon: (i) the degree of reduction in lateral transport required; and (ii) the physical and chemical properties of the contaminants of concern. Vertical subsurface barriers will only be used if it proves necessary to attain equivalent or superior performance, in terms of source control, to the original remedial design. The effectiveness of source control will be evaluated by comparing the original remedial design versus an alternative design in terms of mobility and flow rate of selected constituents from the source.

At this stage in the selection and development of remedial alternatives, specific performance requirements have not been developed for the vertical subsurface barriers. Therefore, process options that are clearly infeasible, provide relatively low effectiveness, or are relatively costly when compared to effectiveness achieved, are eliminated from further consideration, as described below.

Functions

If necessary, a vertical subsurface barrier would be installed along all or a portion of the perimeter of North Dike Area, East Dike Area, or isolated "hot spot" areas to: (i) control lateral migration of waste constituents by providing a low hydraulic conductivity barrier through which ground-water flow velocities are reduced when compared to flow velocities under the current hydrogeological regime; (ii) contain consolidation water; and (iii) in the case of isolated "hot spot" areas, provide physical containment of viscous, tarry wastes.

If the implementation of a vertical subsurface barrier is considered necessary, it would be chosen from available process options to meet specific performance requirements (to be established as part of the remedial design process). A description of each of these process options is provided below.

Slurry Walls

A slurry wall consists of an excavated trench backfilled with a soil-bentonite mixture or cement-bentonite mixture. The trench is excavated while maintaining a slurry of bentonite and water in the trench. The slurry maintains the stability of the trench walls during construction by establishing a filter cake and exerting hydrostatic pressure on the walls. After excavation, the trench is backfilled with the soil-bentonite or cement-bentonite mixture. Figure 7-3 presents diagrams that show typical construction methods used for slurry walls.

Soil-bentonite slurry walls can typically achieve in-place hydraulic conductivities in the range of 1×10^{-6} to 1×10^{-7} cm/s [GeoSyntec, 1994]. Cement-bentonite slurry walls can achieve hydraulic conductivities in the range of 1×10^{-5} to 1×10^{-6} cm/s [GeoSyntec, 1994]. Hydraulic conductivity values for soil samples collected beneath and adjacent to the waste at the Bailey Superfund Site are in the range of 10^{-8} to 10^{-6} cm/s, with most values less than 2×10^{-7} cm/s (see Table 7-2). Since these values are less than, or in the range of, hydraulic conductivities achievable with slurry wall technology, the long-term effectiveness of a slurry wall in containing source contaminants is not significantly different than the effectiveness of the natural soils present at the site. The use of such a wall may only be applicable in areas of the site where natural soil formations have a higher hydraulic conductivity than the slurry wall.

The bottom of the slurry wall is typically excavated into (keyed into) a low hydraulic conductivity layer beneath the waste to create a hydraulic seal at the base of the wall. Since the soil beneath the site has a relatively low hydraulic conductivity, this is not an issue; at the Bailey Superfund Site, the slurry wall would simply extend to an elevation approximately 5 to 10 ft (1.5 to 3.0 m) below the elevation of the bottom of the waste. The required bottom elevation of the slurry wall would be evaluated during the detailed remedial design.

Slurry walls are effective in the short term as they can be constructed relatively quickly. Their effectiveness relative to some other types of vertical subsurface barriers is reduced by the intrusive nature of the construction activities which may expose workers to contaminants. Construction activities could also cause a loss of stability of portions of the dikes. The long-term effectiveness of a slurry wall can be directly related to the bentonite additives that increase the long-term integrity of the wall. Additives would probably be required to compensate for the salinity of the waters at the site (high salinity inhibits the development of a dispersed bentonite fabric during hydration). No reduction in contaminant toxicity or volume would be attained by constructing a slurry wall around the waste.

Since construction of slurry walls is relatively common and the expertise to design and construct slurry walls is readily available, the implementability of this process option is considered good. However, an optimal alignment for any wall could be difficult to achieve based on site constraints (i.e., limited access; location of waste; size of dikes; and proximity of Pond A, the drainage channel, and the North Marsh Area to the waste).

The cost of slurry wall construction is considered moderate to high when compared to the level of effectiveness achieved. This process option may only be applied in isolated areas of the site where natural formations have a greater hydraulic conductivity than a slurry wall.

Jet Grouted Walls

A jet grouted wall acts similarly to a slurry wall in that it reduces ground-water flow and contaminant movement through the wall. A jet grouted wall is constructed by injecting a special fluid containing either grout; grout and air; or grout, air, and water into the subsurface. The fluid is injected at high pressure and velocity from jets lowered into guide holes drilled to the required cut-off elevation. The fluid is injected from the bottom of the hole upward into the guide holes to seal pore spaces of the surrounding soils. The jet grout holes are systematically spaced so that a grouted wall is formed.

Jet grouted walls are most applicable for sites having granular (sandy) subsurface soils [GeoSyntec, 1994]. As previously noted, the subsurface soils at the Bailey Superfund Site are typically fat and lean clays [GeoSyntec, 1995b; GeoSyntec 1996a]. Therefore, jet grouted walls are not necessarily applicable to the subsurface conditions at the Bailey Superfund Site. Jet grouted walls can extend to depths greater than those achieved for slurry walls. The hydraulic conductivity of a constructed jet grouted wall depends on the mixture used for the grout and the type and hydraulic conductivity of the surrounding soils. Hydraulic conductivity values for jet grouted walls are typically similar to those for slurry walls, 1×10^{-6} to 1×10^{-7} cm/s [GeoSyntec, 1994], which is greater than, or in the range of, the hydraulic conductivities of the soils at the site. Jet grouted walls have relatively long construction periods. In addition, jet grouted walls are not a common construction method and would require specialized design and construction expertise.

Jet grouted walls have a relatively high cost when compared to slurry walls. Since their cost is considered high when compared to the level of effectiveness achieved, jet grouted walls would offer little benefit at the Bailey Superfund Site.

Vibrating Beam Walls

Vibrating beam walls are constructed by forcing a vertically suspended, heavy cross-section, wide-flanged steel beam into the ground with a vibrating pile hammer. Grout, which is typically a cement-bentonite mixture, is injected simultaneously under pressure through nozzles on the underside of the beam. The grout lubricates the soil and assists in beam penetration. After the beam is driven to the required depth, it is withdrawn while grout continues to be injected into the void created by the beam. The process is repeated at an adjacent location and a wall is formed by overlapping adjacent drives of the beam. The vibrating beam technique creates a relatively thin wall (3 to 6 in. (75 to 150 mm) thick). Figure 7-4 provides an illustration of a vibrating beam and the resulting wall.

It has been shown that a vibrating beam wall can create an effective barrier in areas where saturated loose granular soils predominate. The technique is less effective in medium to stiff clays and rocky soil which are difficult to penetrate and cause beam deflection. The soils at the site are generally lean and fat clays [GeoSyntec 1995b; GeoSyntec 1996a], which are relatively soft based on visual observation made during the supplemental site investigations. The effective hydraulic conductivities achieved by this method tend to be slightly greater than those for slurry walls and jet grouted walls due to the relatively thin cross sections of the vibrating beam walls [GeoSyntec, 1994]. In addition, the formation of vertical and continuous walls can be difficult, thus increasing the overall hydraulic conductivity of the wall. Therefore, this process option may only be of benefit in isolated areas of the site where the native soils have a higher hydraulic conductivity than the vibrating beam wall.

In comparison to a slurry wall, the vibrating beam method reduces the potential for human contact with waste constituents since no excavation is required. Vibrating beam walls can be used in areas of restricted access, which is a consideration at the Bailey Superfund Site. Since these walls are less common and more complex to construct than slurry walls, specialized design and construction expertise would be required. The construction period for vibrating beam walls can be lengthy, thus increasing cost.

Since the cost of a vibrating beam wall is high compared to the corresponding level of effectiveness achieved, this process option would offer little benefit at the Bailey Superfund Site.

Sheet Pile Walls

Sheet piles could be used to form a vertical barrier to reduce ground-water flow into and out of the waste. To implement this process option, steel or vinyl sheet piles would be driven into the subsurface by a pile hammer or hydraulic press. The primary advantage of sheet piling is that excavation of contaminated materials is not required for their installation. The effectiveness of a sheet pile subsurface barrier is dependent on the effectiveness of the interlocking joints between adjacent sheet piles. Joint sealing methods are available for reducing the leakage between adjacent sheets. Due to the importance of minimizing the potential for leakage through joints, extra effort in improving the joint seal is often warranted. Figure 7-5 provides a photograph of a typical sheet pile wall and several methods for sealing interlocking joints. Principal disadvantages of sheet piling are the high cost, uncertainty in verifying the quality of the joint seals, and potential for corrosion of steel sheet piles.

Polymeric Membrane Walls

This type of vertical subsurface barrier is constructed by installing a series of interlocking polymeric membrane panels vertically into the ground. The membrane is typically manufactured from high density polyethylene (HDPE) which forms an essentially impermeable barrier. Based on a conversion of water diffusion rates through HDPE membranes, equivalent hydraulic conductivities of 1×10^{-11} to 1×10^{-13} cm/s are considered typical for HDPE geomembranes [GeoSyntec, 1994]. The panels used for polymeric membrane walls usually range from 3 to 12 ft (0.9 to 3.7 m) in width. Depending on the depth of installation, the panels can either be placed with the long dimension of the panel aligned horizontally of vertically. Panels can be installed by one of several methods which include: (i) excavation of a self supporting trench; (ii) excavation of a trench stabilized by guide boxes; (iii) vibratory driving of a metal frame supporting a geomembrane panel; (iv) excavation of a bentonite slurry supported trench; and (v) trenching machine excavation. Figure 7-6 presents an illustration of one type of polymeric membrane wall. Polymeric membrane walls have the advantage of forming very low hydraulic conductivity barriers which are resistant to chemical degradation. The disadvantages include higher cost than conventional slurry walls and the intrusive nature of the construction which results in potential contact with contaminated soil by workers.

Due to the relatively low hydraulic conductivity of the native soils at the Bailey Superfund Site, this type of vertical subsurface barrier may be the only process option capable of providing a significant reduction in lateral hydraulic conductivity when compared to the hydraulic conductivity of the native soils surrounding the waste.

Although the cost of this process option is higher than the cost of a conventional slurry wall, it is considered to be cost effective due to its potential effectiveness.

7.4.3.2 Screening of Vertical Subsurface Barrier Process Options

The criteria ratings for the five different process options for vertical subsurface barriers are provided below and in Table 7-1 of this document. The following paragraphs provide a basis for establishing these ratings. A discussion of retained vertical subsurface barrier process options is presented at the end of this section.

Effectiveness

Short term. The vertical subsurface barrier process options described above provide a potentially effective means of physically containing and reducing the mobility of the waste. Vertical subsurface barriers which require excavation for their construction (i.e., slurry walls and possibly polymeric membrane walls) have a lower short-term effectiveness than vertical subsurface barriers which do not require excavation due to potential exposure of site contaminants during construction; however, slurry walls and polymeric membrane walls generally provide a relatively high level of long-term effectiveness. The construction of a slurry wall or polymeric membrane wall may also disturb the integrity of the dikes.

Long term. As previously stated, the selection of a specific vertical subsurface barrier process option is largely dependent on the degree of reduction in hydraulic conductivity required, and the physical and chemical properties of the constituents of concern. Vertical subsurface barriers are effective, proven technologies for reducing the mobility of constituents, but do not result in reduction of toxicity or volume. Based on the hydrogeological conditions at the Bailey Superfund Site and the hydraulic conductivities of the vertical subsurface barriers presented above, the polymeric membrane wall would be the most effective vertical subsurface barrier process option at reducing constituent migration via a ground-water pathway.

Effectiveness Ratings. Based on consideration of the factors presented above, vertical subsurface barrier process options received the following effectiveness ratings:

Vertical Barrier	Short-Term Effectiveness	Long-Term Effectiveness
Slurry walls	2	3
Jet grouted walls	3	2
Vibrating beam walls	3	2
Sheet pile walls	4	2
Polymeric membrane walls	2	4

Implementability

Technical. It is technically feasible to construct most types of vertical barrier walls at the Bailey Superfund Site. However, potential site constraints (i.e., limited access; location of waste; size of dikes; and proximity of Pond A, the drainage channel, and the North Marsh Area to the waste) and the stability of the dikes would need to be evaluated during design.

Administrative. The vertical subsurface barriers described above are proven process options that have been used for the containment of a variety of waste materials. Slurry walls and polymeric membrane walls are most commonly used for applications similar to those for the Bailey Superfund Site. Thus, their implementation should not require lengthy administrative approval. However, vertical subsurface barriers were not included in the ROD or the original remedial design. Therefore, USEPA would need to take administrative action to modify or change the ROD. The necessary equipment and technical expertise to implement these process options are readily available.

Implementability Ratings. Based on consideration of the factors presented above, vertical subsurface barrier process options received the following implementability ratings:

Vertical Barrier	Technical Implementability	Administrative Implementability
Slurry walls	4	4
Jet grouted walls	2	3
Vibrating beam walls	3	4
Sheet pile walls	3	4
Polymeric membrane walls	4	4

Cost

Slurry walls, vibrating beam walls, and jet grouted walls are considered moderately cost-effective process options. Sheet pile walls are less cost effective than those listed above but may be appropriate for the isolation of "hot spot" areas if structural strength is required. Polymeric membrane walls have a relatively moderate construction cost and may be the only vertical membrane barrier process option with a hydraulic conductivity significantly lower than the native soils surrounding the waste.

Based on consideration of the factors presented above, vertical subsurface barrier process options received the following cost ratings:

Vertical Barrier	Cost
Slurry walls	3
Jet grouted walls	2
Vibrating beam walls	2
Sheet pile walls	2
Polymeric membrane walls	4

Screening Summary

Vertical subsurface barriers are considered a potential enhancement to a cap or for use around isolated areas of the site that may contain sludge-like waste. Based on an evaluation of the ratings presented in Table 7-1 for the vertical subsurface barrier process options, the following process options have been retained for further consideration as enhancements to a cap remedy:

- slurry walls - total rating score: 16; and

- polymeric membrane walls - total rating score: 18.

The need for these process options is evaluated as part of the analysis of technical equivalency presented in Section 8 of this FFSR. The selection of a specific process option would be based on the performance requirements identified during the detailed remedial design. Polymeric membrane walls would be appropriate if it is necessary to achieve a very high degree of lateral containment.

In addition to slurry walls and polymeric membrane walls, sheet pile walls have been retained for further consideration for use around limited areas of the site. Sheet pile walls may be appropriate for the isolation of "hot spot" areas if structural wall strength is required.

7.4.4 In-Situ Treatment Technologies

In-situ solidification is the only in-situ remedial technology that survived preliminary screening. In-situ solidification process options are described and screened in the following sections. The ratings for the in-situ solidification process options are presented in Table 7-1.

General Description of Process Options

In-situ solidification refers to the mechanical mixing of wastes and affected soils in place with a solidification admixture. Typical admixtures may include cement, bentonite, lime kiln dust, and/or flyash. The admixtures can be introduced either as a dry powder or slurry. In-situ solidification has been traditionally used for immobilizing inorganic compounds such as metals in contaminated soils and sludges and for improving the physical/mechanical properties of these materials.

Function

In-situ solidification is typically performed to achieve one or both of the following objectives:

to reduce the mobility of leachable constituents in wastes and affected soils; and

to improve the strength of the waste and affected soils.

7.4.4.1 In-Situ Solidification - Original Remedial Design

The original remedial design included a requirement to solidify the waste to *"reduce the mobility of the waste and provide strength to support a clay cap"* [USEPA, 1988a]. Treatability testing results presented the FS report and SER show that solidification produced a reduction in the leachability of certain waste constituents. The waste solidification component of the original remedial design included specified performance criteria for unconfined compressive strength and hydraulic conductivity for the solidified material. The performance criterion for unconfined compressive strength was established at 25 psi (172 kPa). The hydraulic conductivity performance criterion for the solidified waste was 1 x 10^{-6} cm/s.

In-situ solidification activities were performed on waste in the southern portion of the East Dike Area of the Bailey Superfund Site during 1993 and 1994. During initial attempts to solidify waste in the East Dike Area, Chem Waste encountered difficulties in achieving the specified physical and hydraulic characteristics (i.e., unconfined compressive strength and hydraulic conductivity) for the solidified waste. As a result of these difficulties, the RA work eventually ceased in early 1994.

After Chem Waste stopped the work, the BSSC retained independent contractors and consultants to perform a pilot study to evaluate the feasibility of implementing the original remedial design (i.e., in-situ solidification) and achieving the specified physical and hydraulic characteristics at a location in the East Dike Area, which is adjacent to the previously solidified material. The study indicated that solidification could be performed at that location in general conformance with the specified performance criteria. The study concluded, however, that to meet the specified performance criteria, conformance testing needed to be based on wet sampling of uncured material, followed by laboratory curing, rather than coring of material cured in-situ (as had initially been performed in accordance with the construction specification) [McLaren/Hart and Kiber, 1995]. Importantly, the study did not address the feasibility of solidification in other areas of the site (i.e., the North Dike Area and the northern-middle and northern portions of the East Dike Area).

The area of the East Dike solidified in 1993 and 1994 is described as having black cindery waste containing no municipal waste. Other portions of the East Dike Area have been described as containing various amounts of MSW, debris, tarry waste, and waste with high organic contents.

In August 1995 and November 1995, GeoSyntec performed supplemental site investigations of the North Dike Area and East Dike Area, respectively, to evaluate the waste composition in these areas. The results of these investigations are summarized in Section 3 of this FFSR. The results of the supplemental site investigations for the North Dike Area and East Dike Area indicate that municipal and industrial wastes were co-disposed at the Bailey Superfund Site. The North Dike Area contains municipal waste, large items of debris, tarry waste, rubber crumb, and other rubbery waste. The East Dike Area contains municipal waste and rubber crumb (northern portion), hard rubber crumb and other rubbery waste (northern-middle portion), and rubber crumb and other rubbery waste (southern-middle portion). The waste within the southern portion of the East Dike Area was solidified as part of the original remedial action. In addition, the waste materials within the North Dike Area and East Dike Area have a high organic content.

Based on the volume, composition, heterogeneity, and organic content of the waste, successful in-situ solidification of the waste to the specified performance criteria is technically infeasible, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified. Successful implementation of the in-situ solidification remedy for the remainder of the site would be difficult or impracticable to implement using cost effective and reliable construction techniques. The logical framework used to evaluate the solidification component of the original remedy was presented in Section 3.2 of this FFSR.

7.4.4.2 In-Situ Solidification - Alternate Performance Criteria

This process option would involve in-situ solidification of the waste to alternate performance criteria that would include unconfined compressive strength only. The solidification process would be similar to the original remedial design, but hydraulic conductivity would be eliminated as a performance criterion. Based on a review of work performed during the original RA, the unconfined compressive strength criterion would be achievable if the sampling method is modified. Also, during earlier attempts to solidify the waste in the East Dike Area, the attained unconfined compressive strength test values were adequate to support the weight of either a single component or lightweight composite cap. The elimination of the hydraulic conductivity criterion would allow for broader application of the in-situ solidification process option. If this process option were selected for limited portions of the East Dike Area and other selected areas (i.e., Pit B), the strength performance criterion would be evaluated during remedial design and established at a value that is both achievable and appropriate with respect to other remedy components.

7.4.4.3 In-Situ Solidification - Method-Based Specification

For this process option, the waste would be solidified based on a specified mixing method and rate of application for the solidification admixture. The physical characteristics of the solidified waste, such as compressive strength and hydraulic conductivity, would not be the basis for acceptance of a completed area, but would be evaluated at either laboratory or pilot scale, and empirically correlated to the specified construction method. Quality assurance would be based on monitoring the equipment, methods, and admixture application rates to make sure they were in accordance with the technical specifications. This approach would be advantageous since it would not require extensive sampling and testing during construction operations, and would therefore eliminate the uncertainties of correlating discrete performance testing to in-situ conditions.

HLA prepared the SER for BSSC which included an evaluation of stabilization methods for the Bailey Superfund Site. Four techniques were evaluated including: (i) inject and mix; (ii) pneumatic spreading; (iii) closed-loop consolidation; and (iv) excavation/stabilization. Each technique was evaluated with respect to the following:

- uniformity - ease and completeness of mixing;
- operation - logistics of the equipment and process;
- equipment - availability of equipment;
- speed - production speed;

- emissions - degree of emissions generated due to the equipment and procedure;
- physical handling - amount of physical handling of waste required by site personnel;
- adaptability - ability to adapt to varying or changed conditions that might be expected at the site; and
- limitations - depth capability and waste characteristics restrictions.

If this process option were selected for portions of the site, the appropriate method would be evaluated during the remedial design based on existing information and supplemental information gathered during the FFS and subsequent design activities.

7.4.4.4 Secondary Screening of In-Situ Solidification Process Options

The in-situ solidification process options retained following the preliminary screening are very similar except for the technical criteria that would be included in the construction specifications. The process options were evaluated according to the five previously-described criteria. The results of the secondary screening are provided below and in Table 7-1. A summary of the criteria evaluations for the in-situ solidification process options is included below.

Effectiveness

Short term. The short-term effectiveness of these process options is considered to be moderate since the treatment activities are performed in-situ. However, contaminant exposure to precipitation, stormwater, and the atmosphere could occur. In addition, the implementation period for these process options can be lengthy.

Long term. If these process options can be successfully implemented, they typically are effective at reducing contaminant mobility. Based on information provided in the FS report and SER (TCLP testing results), the toxicity of the leachate from the solidified waste samples is less than the toxicity of unsolidified waste samples.

However, they do not reduce the toxicity of the constituents, and they increase the volume of the waste material.

Effectiveness Ratings. Based on consideration of the factors presented above, in-situ solidification process options received the following effectiveness ratings:

Solidification Process	Short-Term Effectiveness	Long-Term Effectiveness
Original remedial design	1	2
Alternate performance criteria	3	3
Method-based specification	3	3

Implementability

Technical. Based on the results of the supplemental site investigations for the North Dike Area and East Dike Area, successful implementation of in-situ solidification to the specified performance criteria is technically infeasible for these areas, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified. In-situ solidification of these areas with alternative performance criteria or a method-based specification could be achieved, but it would also be difficult, time consuming, and costly to implement. In addition, in-situ solidification of the waste for the purpose of increasing its strength to support a cap is not warranted based on the apparent strength of the waste material.

In-situ solidification could potentially be implemented in areas that contain sludge-like waste, very little to no co-disposed waste (industrial waste and MSW), or soft rubbery waste, provided that the performance criteria in the original remedial design were modified to include alternate performance criteria or a method-based specification.

Administrative. The selected remedy in the ROD includes in-situ solidification of the waste, but does not provide the performance criteria (unconfined compressive strength or hydraulic conductivity criteria) for the solidified waste. The specified performance criteria was established by HLA during remedial design. Since the performance criteria are not part of the ROD, a modification to the performance criteria to include alternate performance criteria or a method-based specification could be performed without having to change or modify the ROD, and thus decrease potential administrative difficulties.

Implementability Ratings. Based on consideration of the factors presented above, in-situ solidification process options received the following implementability ratings:

Solidification Process	Technical Implementability	Administrative Implementability
Original remedial design	1	4
Alternate performance criteria	2	3
Method-based specification	2	3

Cost

These process options are relatively costly based on the cost estimates to implement the original remedial design. However, cost savings could be achieved if alternate performance criteria or a method-based specification were implemented.

Based on consideration of the factors presented above, in-situ solidification process option received the following cost ratings:

Solidification Process	Cost
Original remedial design	1
Alternate performance criteria	3
Method-based specification	3

Screening Summary

Based on the evaluation of the process options and the individual process option ratings provided above and in Table 7-1, none of these process options were retained for further consideration for area-wide application to the North Dike Area and East Dike Area. However, the alternate performance criteria and method-based specification process options will be considered in Sections 9 and 10 of this document for areas containing sludge-like or problematic wastes.

7.4.5 Off-Site Disposal

General Description of Process Option

This process option involves the use of mechanical excavation equipment to excavate and load wastes for off-site disposal at a permitted hazardous waste (RCRA Subtitle C) or equivalent landfill. Ex-situ solidification of the excavated waste would be performed, if required, to meet regulatory requirements and/or landfill disposal requirements. This process option could be utilized for waste from the entire site or for waste from isolated "hot spot" areas.

Function

The objective of off-site disposal is to remove the source (waste and affected soils) from the site. Excavated materials would be disposed and managed at a permitted commercial facility; thereby, reducing contaminant mobility.

Effectiveness

Short term. Excavation of the waste would increase the potential for contaminant exposure for humans, wildlife, precipitation, and stormwater runoff. The construction activities associated with this process option would result in the need for the following measures to limit human exposure and adverse environmental impacts: (i) dust suppression; (ii) equipment and personnel decontamination facilities; (iii) use of personnel protection equipment; and (iv) stormwater control. Depending on the depth of excavation, excavation dewatering may be required and potentially contaminated ground water and stormwater runoff would need to be properly managed.

Long term. The long-term effectiveness of this process option is considered moderate. The toxicity, mobility, and volume of on-site constituents would be significantly reduced if the waste were excavated and placed in an off-site landfill. However, the toxicity and volume of the waste material would ultimately remain unchanged by relocating it. The mobility of the waste material would be reduced by placing it in a hazardous waste (RCRA Subtitle C) or equivalent landfill. Wastes would be solidified (if required) prior to placement in the landfill to facilitate handling and further reduce the mobility of contaminants.

Effectiveness Ratings. Based on consideration of the factors presented above, off-site disposal received the following effectiveness ratings:

- Short-Term Effectiveness Rating: 2; and
- Long-Term Effectiveness Rating: 3.

Implementability

Technical. The waste material could be very difficult to excavate and load into trucks due to: (i) the composition and consistency of the waste; and (ii) difficulties with controlling seepage into excavations. Air emissions during excavation, if not adequately managed, could pose a risk to workers at the site. The North Dike Area and the northern portion of the East Dike Area contain co-disposed waste (MSW, debris, rubber crumb, and tarry materials) which would make waste handling cumbersome. However, isolated areas of sludge-like wastes could be excavated and disposed off site with less difficulty than the co-disposed waste. The approach of only removing isolated areas of waste is consistent with "*Presumptive Remedies for CERCLA Municipal Landfill Sites*" [USEPA, 1993b], which recognizes the difficulties associated with large-scale removal of problematic waste.

Administrative. If this technology were selected, the necessary regulatory approvals and requirements could be met with a moderate amount of effort. The removal and off-site disposal of waste from isolated areas is consistent with USEPA guidance for remediating sites with large quantities of problematic wastes. Permitted disposal facilities for the disposal of the waste are available in the general proximity of the site. The disposal facility may need to perform some level of solidification of the waste prior to disposal.

The selected remedy in the ROD did not include off-site disposal of waste and affected soil; therefore, USEPA would need to take administrative action to change or modify the ROD.

Implementability Ratings. Based on consideration of the factors presented above, off-site disposal received the following implementability ratings:

- Technical Implementability Rating: 1; and
- Administrative Implementability Rating: 3.

Cost

The costs to implement an off-site disposal process option for the North Dike Area and East Dike Area are likely high due to a long construction period, transportation costs, and disposal costs. However, off-site disposal of wastes for isolated areas is considered more cost effective because: (i) the volume of the waste would be less; (ii) the waste would be easier to remove and transport, thus reducing the construction period; and (iii) other areas of the site could be remediated using other cost effective process options.

Based on consideration of the factors presented above, off-site disposal received the following cost rating:

- Cost Rating: 2.

Screening Summary

Based on the evaluation of this process option, which received a total rating score of 11, it will not be retained for further consideration, except for isolated "hot spot" areas. This approach is consistent with USEPA guidance for remediating sites with large quantities of problematic waste.

7.5 Summary

7.5.1 Process Options for the Entire Site

The following process options were retained and will be considered during the development of the remedial alternative for the Bailey Superfund Site in Section 9 of this FFSR:

- lightweight composite cap;
- consolidation water collection system;
- slurry wall; and
- polymeric membrane wall.

The need for a consolidation water collection system, slurry wall, or polymeric membrane wall is evaluated as part of the analysis of technical equivalency presented in Section 8 of this FFSR.

7.5.2 Additional Process Options for Isolated "Hot-Spot" Areas

The following additional process options will be considered for isolated areas of the site containing sludge-like wastes.

- sheet pile walls;
- in-situ solidification - alternate performance criteria;
- in-situ solidification - method-based specification; and
- off-site disposal.

TABLE 7-1
SECONDARY SCREENING OF PROCESS OPTIONS
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Process Options	Effectiveness		Implementability		Cost	Total Rating Score	Reject or Retain for the Entire Site
	Short-Term	Long-Term	Technical	Administrative			
Capping							
Single Component Cap	3	3	2	3	3	14	Reject
Lightweight Composite Cap	4	4	5	5	3	21	**Retain**
Consolidation Water Absorption Layer	4	3	2	4	2	15	Reject
Consolidation Water Collection System	4	4	4	4	3	19	**Retain**
Vertical Subsurface Barriers							
Slurry Wall	2	3	4	4	3	16	**Retain**
Jet Grouted Wall	3	2	2	3	2	12	Reject
Vibrating Beam Wall	3	2	3	4	2	14	Reject
Sheet Pile Wall	4	2	3	4	2	15	Reject[1]
Polymeric Membrane Wall	2	4	4	4	4	18	**Retain**
In-Situ Treatment							
Solidification—Original Remedial Design	1	2	1	4	1	10	Reject
Solidification—Alternate Performance Criteria	3	3	2	3	3	14	Reject[1]
Solidification—Method-Based specification	3	3	2	3	3	15	Reject[1]
Off-Site Disposal							
Mechanical Excavation/Ex-Situ Solidification (if required)/Off-Site Disposal	2	3	1	3	2	11	Reject[1]

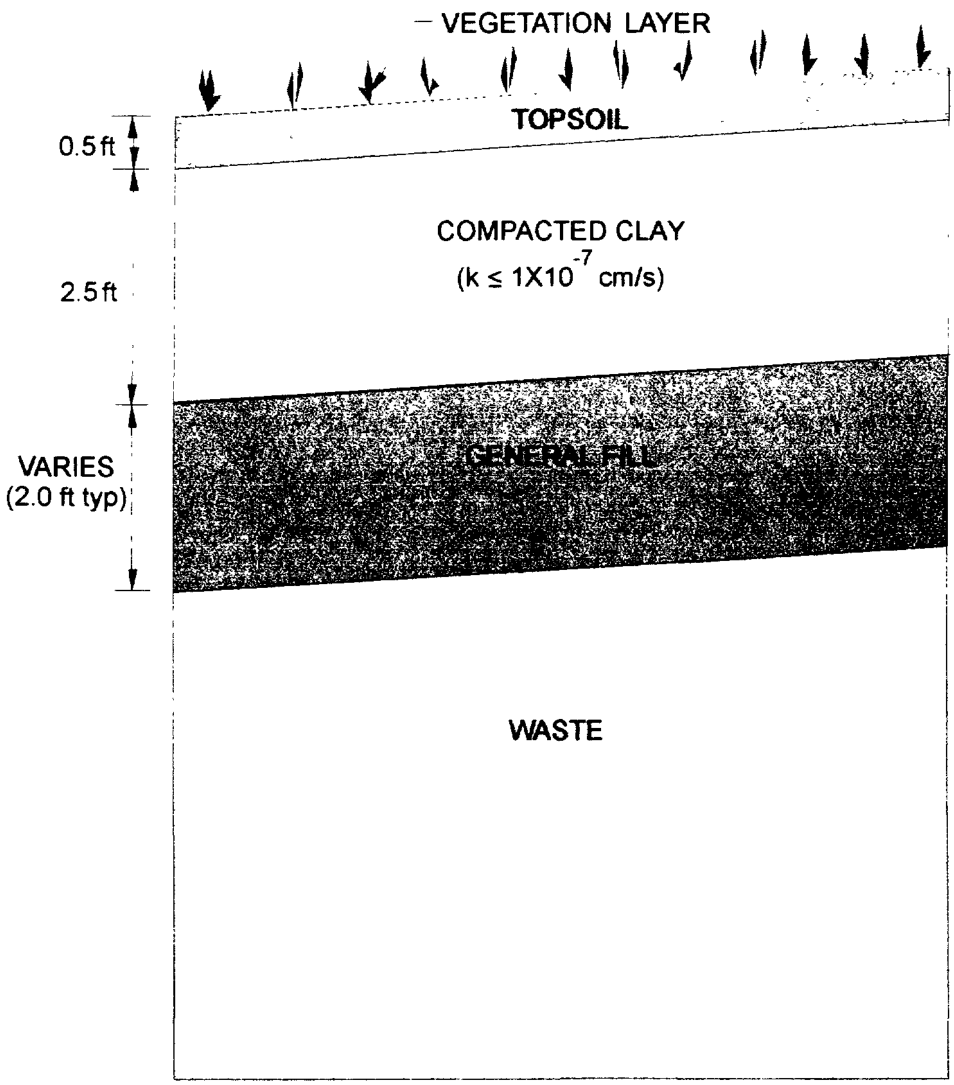
[1] These process options are rejected for application to the entire site, but are retained for isolated "hot-spot" areas.

TABLE 7-2
SUMMARY OF HYDRAULIC CONDUCTIVITY TESTING RESULTS
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Sample Identification	Depth (ft)	Hydraulic Conductivity (cm/s)	Location	Source
DSB-3	12 to 14	2.6×10^{-8}	Southern portion of East Dike Area	RI[1]
DSB-3	33 to 35	1.0×10^{-8}	Southern portion of East Dike Area	RI
DSB-4	14 to 16	5.8×10^{-8}	Northern portion of East Dike Area	RI
DSB-4	28 to 30	1.0×10^{-8}	Northern portion of East Dike Area	RI
G-TP6-S-1	12 to 13	1.1×10^{-7}	Center portion of North Dike Area	TM-NDA[2]
G-TP8-S-1	7 to 8	1.6×10^{-7}	Western portion of North Dike Area	TM-NDA
G-TP13-S-1	8.5 to 9	3.3×10^{-7}	Eastern portion of North Dike Area	TM-NDA
G-TP14-S-1	7 to 8	6.5×10^{-9}	Northern portion of East Dike Area	TM-EDA/PB[3]
G-TP15-S-1	9 to 10	1.8×10^{-8}	Northern portion of East Dike Area	TM-EDA/PB
B2	6.5 to 7.0	9.0×10^{-9}	Western portion of Pit B	PBPDS[4]
D1	7.0 to 7.5	1.2×10^{-8}	Center portion of Pit B	PBPDS
ND-B-1.1	2 to 4	3.2×10^{-7}	Western portion of North Dike Area	SPDS[5]
ND-B-1.2	8 to 10	3.1×10^{-7}	Western portion of North Dike Area	SPDS
ND-B-2.1	2 to 4	1.4×10^{-7}	Western portion of North Dike Area	SPDS
ND-B-2.2	8 to 10	2.4×10^{-7}	Western portion of North Dike Area	SPDS
ND-B-3.1	2 to 4	1.9×10^{-8}	Western portion of North Dike Area	SPDS
ND-B-3.2	8 to 10	1.5×10^{-7}	Western portion of North Dike Area	SPDS
ND-B-4.1	2 to 4	7.6×10^{-7}	Center portion of North Dike Area	SPDS
ND-B-4.2	8 to 10	4.2×10^{-6}	Center portion of North Dike Area	SPDS
ND-B-5.2	8 to 10	4.1×10^{-8}	Eastern portion of North Dike Area	SPDS
ND-B-6.2	8 to 10	2.6×10^{-6}	Eastern portion of North Dike Area	SPDS
ED-B-1.1	3 to 4.7	1.5×10^{-7}	Northern portion of East Dike Area	SPDS
ED-B-1.2	11 to 13	1.1×10^{-8}	Northern portion of East Dike Area	SPDS

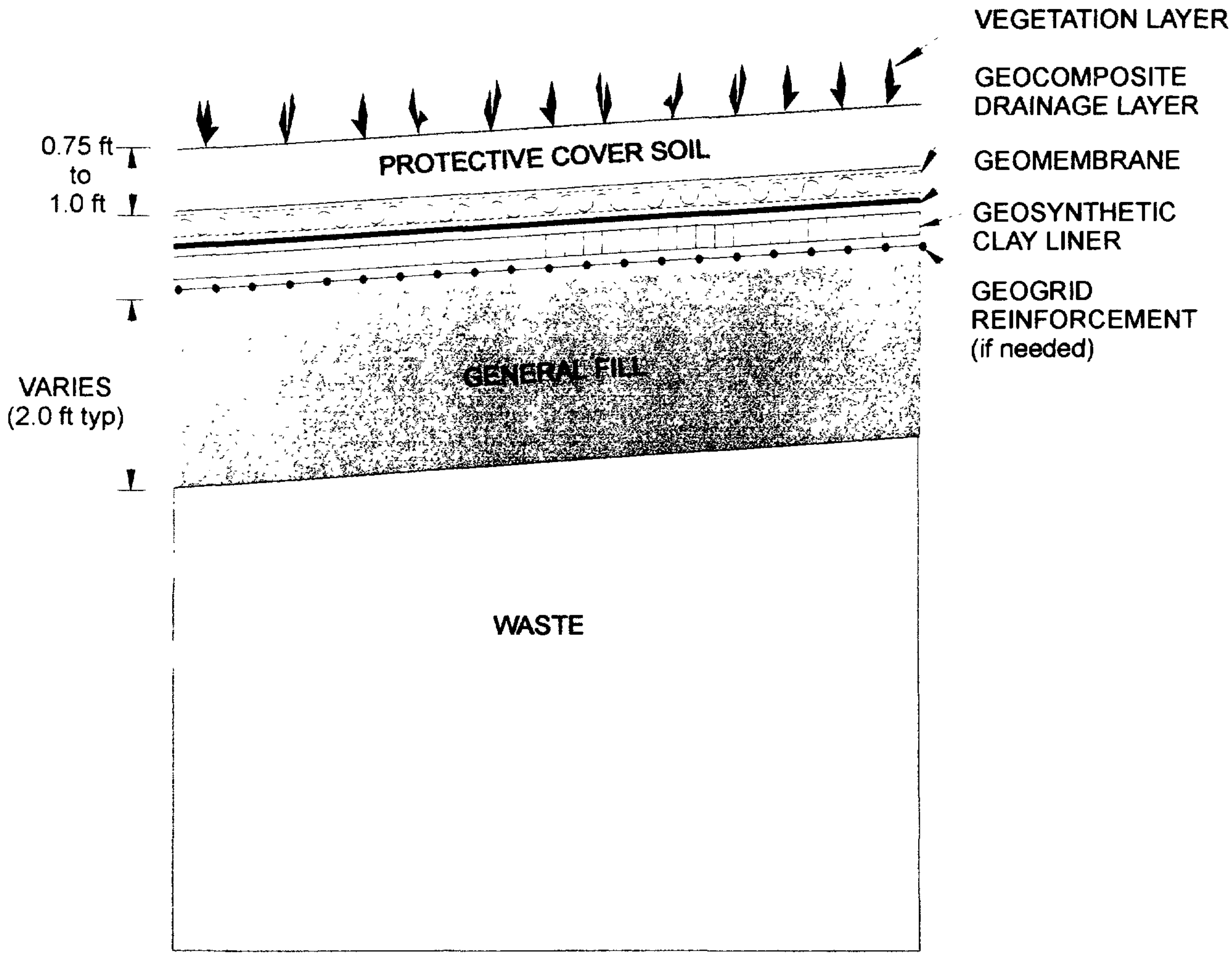
1. *Bailey Dump Superfund Site, Remedial Investigation, Orange County, Texas,* Woodward-Clyde Consultants, 1987.
2. *Technical Memorandum, Supplemental North Dike Area Site Investigation and Evaluation of Original Remedy, Bailey Superfund Site, Orange County, Texas,* GeoSyntec Consultants, 1995.
3. *Technical Memorandum, Supplemental East Dike Area and Pit B Site Investigations, Bailey Superfund Site, Orange County, Texas,* GeoSyntec Consultants, 1996.
4. *Technical Memorandum, Pit B Pre-design Study, Bailey Superfund Site, Orange County, Texas,* GeoSyntec Consultants, 1996.
5. Sitewide Pre-design Study (technical memorandum for this work is not yet completed).

SINGLE COMPONENT CAP



GEOSYNTEC CONSULTANTS ATLANTA GEORGIA	FIGURE NO.	7 - 1
	PROJECT NO.	GE3913-10
	DOCUMENT NO.	GA951411
	FILE NO.	OR-REM.CDR

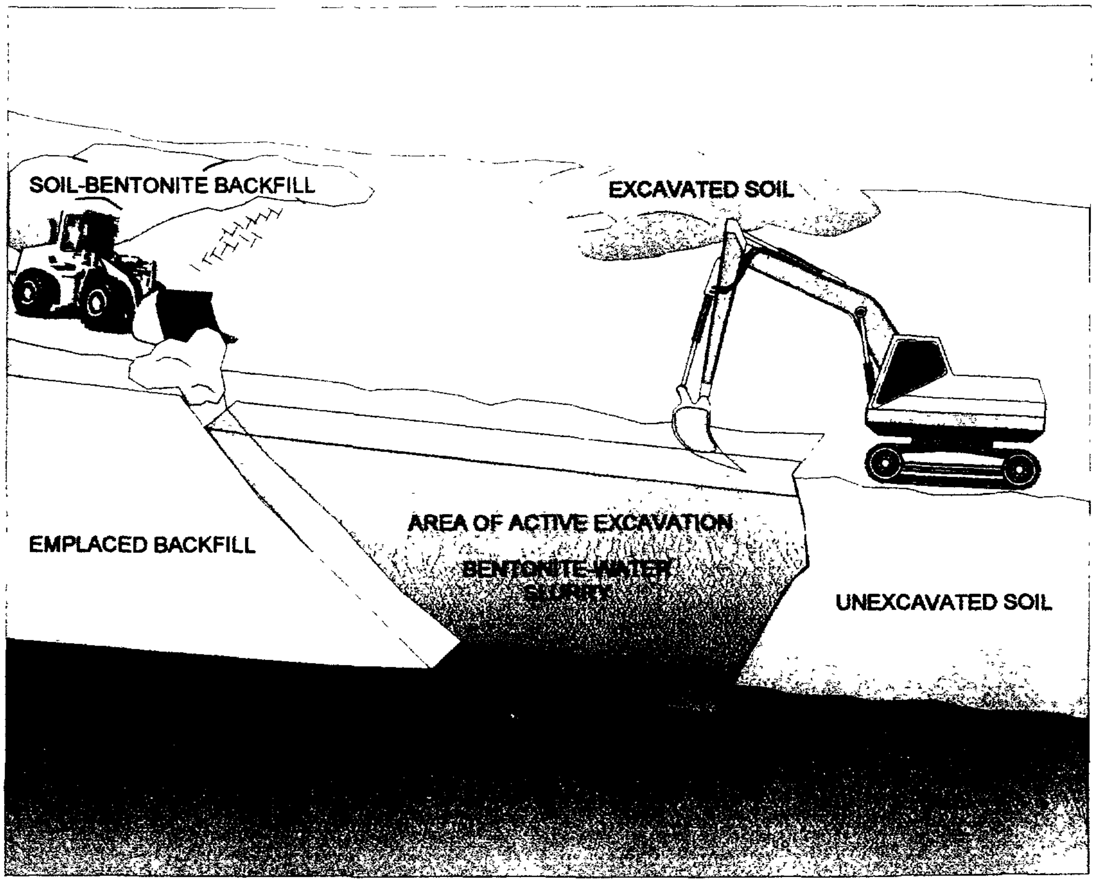
LIGHTWEIGHT COMPOSITE CAP



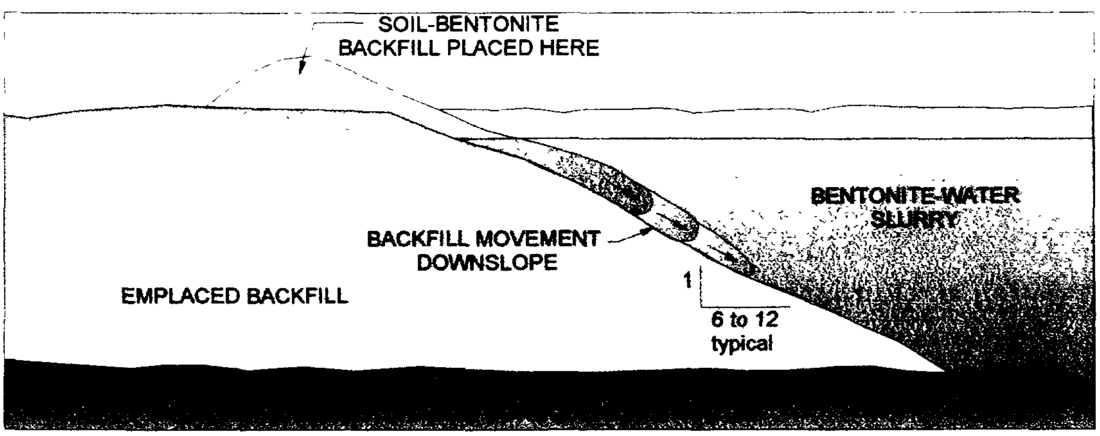
GeoSyntec Consultants
ATLANTA, GEORGIA

FIGURE NO.	7 - 2
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	PROP-REM.CDR

SLURRY WALL CONSTRUCTION METHODS



OVERALL CONSTRUCTION OPERATIONS



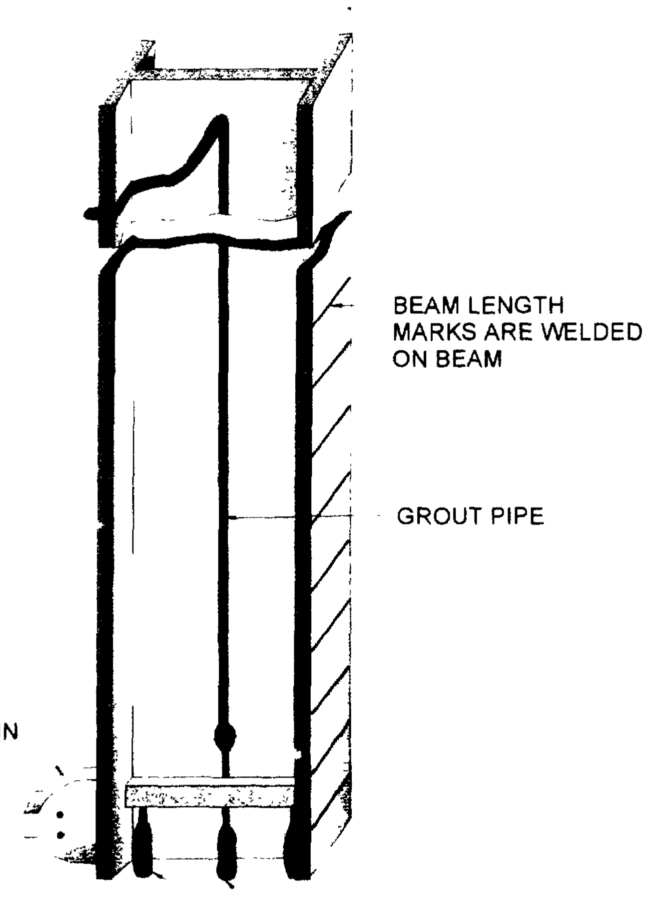
SCHEMATIC OF BACKFILLING SOIL-BENTONITE SLURRY

SOURCE: AFTER EVENS, 1991

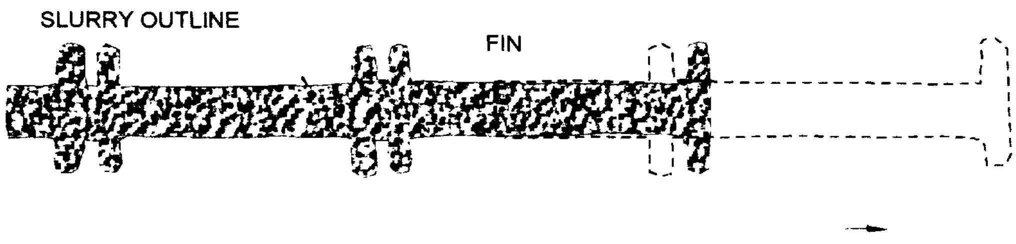
GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	7 - 3
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	CONSTRU.CDR

VIBRATING BEAM WALL



TYPICAL BEAM CONFIGURATION



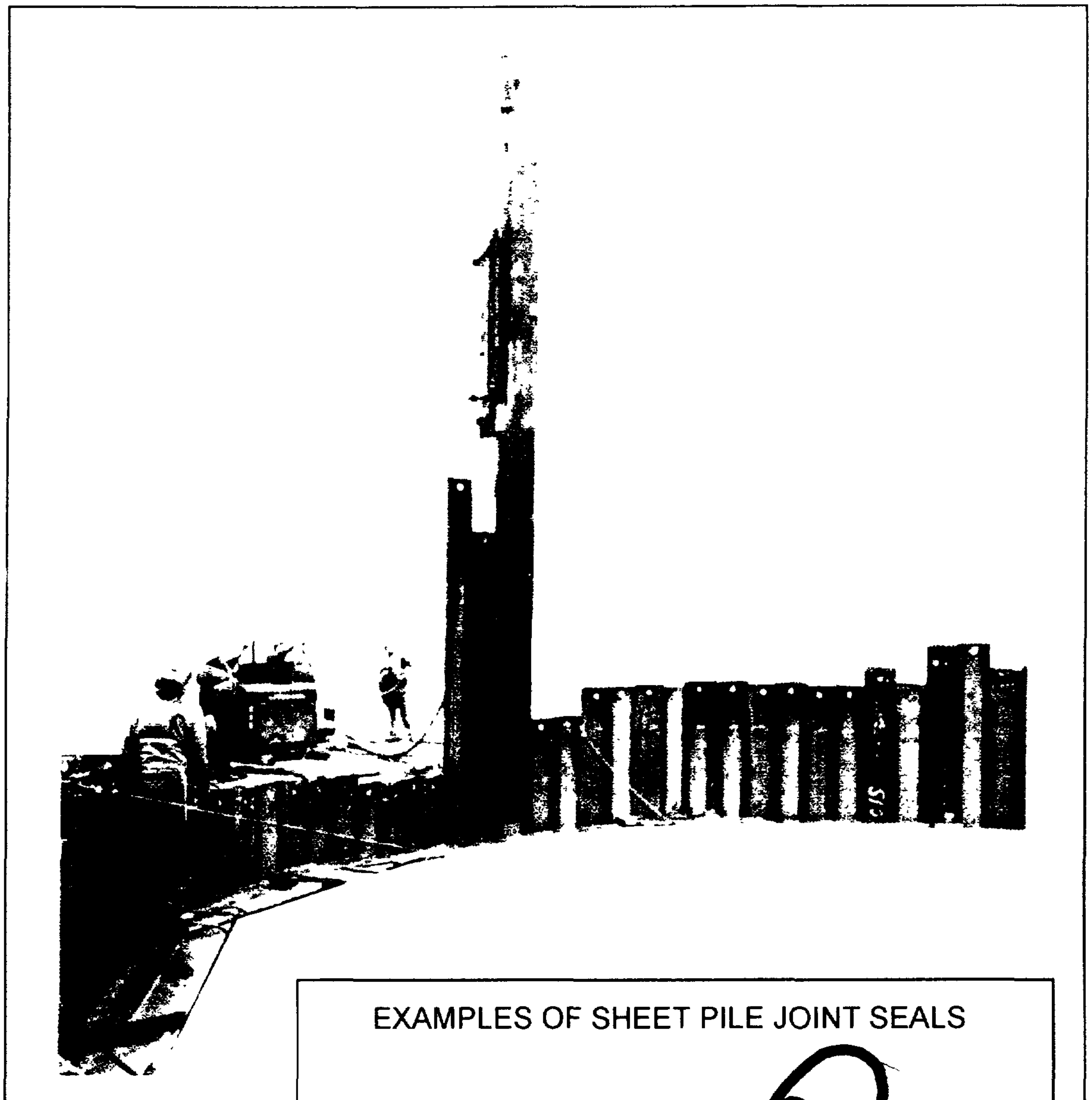
PLAN VIEW OF WALL INSTALLATION

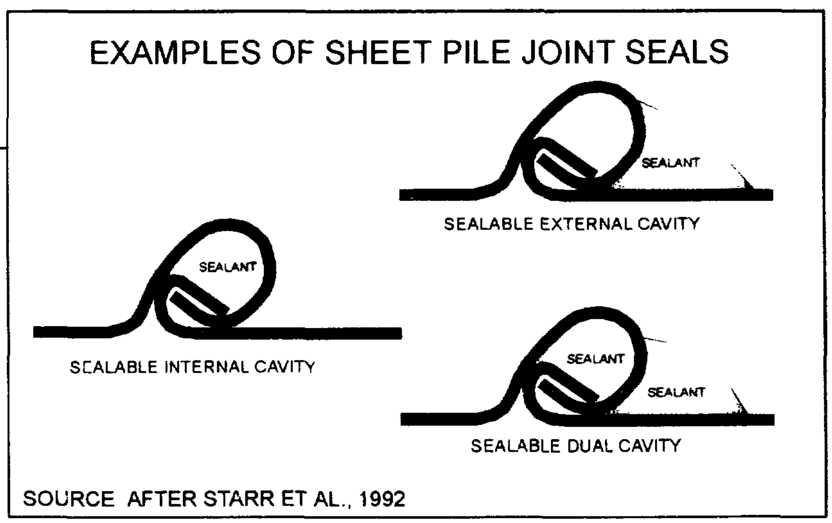
SOURCE. AFTER LEONARDS ET AL , 1985

GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO	7 - 4
PROJECT NO	GE3913-10
DOCUMENT NO	GA951411
FILE NO	GROUT.CDR

SHEET PILE WALL

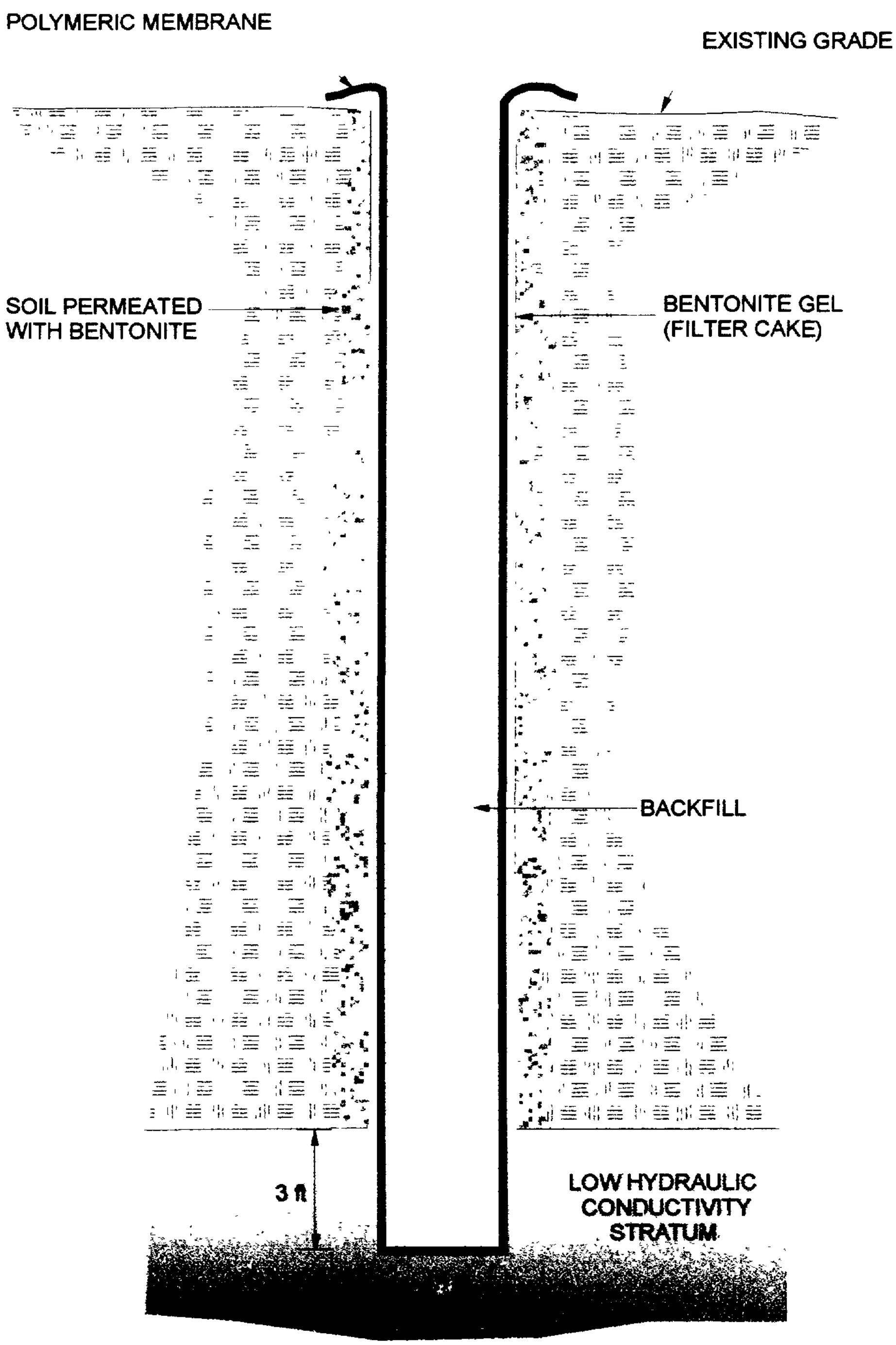




GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO	7 - 5
PROJECT NO	GE3913-10
DOCUMENT NO	GA951411
FILE NO	SEALS CDR

POLYMERIC MEMBRANE WALL



SOURCE: AFTER EVENS, 1991

GeoSyntec Consultants
ATLANTA, GEORGIA

FIGURE NO.	7 - 6
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	MEMWALL.CDR

8. ANALYSIS OF TECHNICAL EQUIVALENCY

8.1 Introduction

This section of the FFSR addresses the technical equivalency of alternative remedies for the Bailey Superfund Site. In accordance with Task 8 of the Work Plan, technical equivalency is evaluated by comparing the source contaminant performance of selected process options that survived the secondary screening in Section 7 of this report to the source contaminant performance of the original remedial design.

The approach to performing the analysis of technical equivalency utilizes an idealized one-dimensional model that is considered appropriate for the purpose of comparing the relative performance of two potential remedies. In performing the analysis, a number of simplifying assumptions were made to model the waste as homogenous material. It is recognized that other sections of this FFSR present information indicating that waste at the Bailey Superfund Site is comprised of a wide range of materials of differing physical and chemical consistencies, strengths, moisture contents, and particle sizes. Notwithstanding this fact, the assumptions made herein are considered appropriate for the purpose of performing the comparative analysis.

While the use of multi-dimensional analysis methods coupled with more complete material behavioral models would provide numerical results that would more accurately reflect the actual behavior of potential remedies for the Bailey Superfund Site, it is unlikely that they would significantly change the comparative results and the conclusions of the analysis of technical equivalency. This reasoning, coupled with the time and effort associated with the use of more complex multi-dimensional modeling methods, justifies the use of the one-dimensional model presented in this report. The assumptions used in the development of the one-dimensional model are presented in Section 8.3 of this FFSR.

To perform the analysis, one potential remedial alternative was assembled from the process options that survived the secondary screening. This potential remedial alternative includes only the major components of the alternative (i.e., only the component(s) that address primary source control). Section 9 of the FFSR addresses the complete development and assembly of process options and addresses both primary and secondary components such as surface-water management, access roads, etc.

Major components of the original remedial design and the potential remedial alternative that were evaluated in terms of technical equivalency are as follows:

Original Remedial Design

The major components of the original remedial design (ORD) are: (i) solidification of the waste; and (ii) construction of a single component cap over the solidified waste. The evaluation of the ORD is presented as a baseline for the comparison of the potential remedial alternative.

Potential Remedial Alternative

The major component of the potential remedial alternative (PRA) is a lightweight composite cap that would be constructed over the waste areas without prior solidification of the waste. Remedy enhancements (as described in Section 7), principally a consolidation water collection system, would be used if found to be necessary to achieve technical equivalency to the ORD.

8.2 Overview of Analysis of Technical Equivalency

The purpose of the analysis of technical equivalency is to compare the total weighted source flux (WSF) from the source for the PRA to the total WSF for the ORD. The WSF is a relative measure of the flux of an indicator chemical from the source, with the flux weighted on the basis of the relative toxicity of the indicator chemical. The total WSF is the sum of the WSFs for the indicator chemicals under consideration. The weighting factor applied to each indicator chemical is the maximum toxicity constant for water (T_c) for that chemical. For consistency with previous studies, numerical values of toxicity constants were taken from the RI risk assessment.

The PRA is considered "equivalent" to the ORD if the total WSF for the PRA is equal to or less than the total WSF for the ORD. In this case, the overall performance of the PRA would be further evaluated in the FFS. If the results of the analysis of technical equivalency indicate that the total WSF for the PRA is larger than that for the ORD, remedy enhancements would need to be evaluated.

An analysis procedure was developed to evaluate the total WSF for the PRA for the Bailey Superfund Site. This procedure includes: (i) evaluation of potential sources of liquids that could contact or flow out of the waste source; (ii) calculation of the volume of liquid associated with each source; (iii) evaluation and quantification of the potential mechanisms of flow from, or active removal of, liquid from the waste mass; (iv) calculation of a water balance model and any net outflow from the waste to the surrounding subsurface soils; and (v) estimation of the maximum concentrations of indicator chemicals in any net outflow resulting from the water balance results.

Three potential sources of liquid were evaluated: (i) ground-water inflow into the waste mass; (ii) rainwater infiltration through the cap system; and (iii) water squeezed from the waste due to waste consolidation under the weight of the fill and cap system constructed during the remedial action. Two potential mechanisms for liquid reduction in the waste mass were evaluated: (i) liquid from waste consolidation that is collected and removed by an engineered collection and removal system; and (ii) net outflow. The total net outflow was calculated using the water balance model shown schematically in Figure 8-1. The simplifying assumptions used to develop the analysis of technical equivalency are presented in Section 8.3. The calculation procedures and models used to evaluate the volume of liquid associated with each component of the water balance is described in Section 8.4.

8.3 Analysis Assumptions

8.3.1 Overview

As stated previously, the purpose of the analysis of technical equivalency is to compare the weighted WSF for the PRA to that for the ORD. The analysis is not presented as a quantitative measure of performance, but only as an indicator of relative performance. The following sections address the assumptions made in the analysis of technical equivalency.

8.3.2 Assumptions Common to Both Alternatives

For the analysis performed herein, the WSF for a given chemical is the product of the total net outflow from the water balance analysis, Q_n, the concentration of the considered indicator chemical in TCLP extract, C_0, and the maximum toxicity constant for that chemical in water, T_c, and the number of indicator chemicals considered in the analysis (m). Basic English units are: Q_n (in.), C_o (ppm), T_c (ppm^{-1}). Basic SI units are: Q_n (mm); C_o (mg/l), T_c (l/mg). The total WSF is obtained by summing the individual WSFs over the m (dimensionless) indicator chemicals. Based on this approach, technical equivalency is achieved if:

$$\sum_{i=1}^{m}(Q_n \times C_o \times T_c)_{PRA} \le \sum_{i=1}^{m}(Q_n \times C_o \times T_c)_{ORD} \qquad \textbf{(Equation 8-1)}$$

Indicator Chemicals and Toxicity Constants

The actual calculation of the WSF considers each indicator chemical separately (i.e., C_0 and T_c varies for each indicator chemical). For consistency with previous work for the Bailey Superfund Site, indicator chemicals and toxicity constants used in the analysis of technical equivalency were those used in the RI. Only indicator chemicals that have associated toxicity constants and TCLP data were considered in the analysis. These chemicals are arsenic, benzene, ethylbenzene, lead, and trichloroethylene. TCLP data also exist for styrene, but the RI does not provide a toxicity constant for this chemical. Therefore, styrene was excluded from the analysis. However, based on the concentrations of styrene in the TCLP extract from the unsolidified and solidified waste samples from the Bailey Superfund Site, and the comparatively low toxicity of this chemical compared to benzene or trichloroethylene, the exclusion of this chemical in the comparative analysis has no significant effect on the analysis results.

TCLP Data

TCLP data for both the unsolidified and solidified waste were obtained from the SER. In each case, the representative TCLP result for each indicator chemical was selected as the average of the TCLP results. Separate representative TCLP values were calculated for the unsolidified and solidified samples. In most cases, these individual test results were used to calculate the representative value. TCLP extract results reported in the SER as "BDL," defined as below detection limit, were given a value of zero for the analysis. It is noted, however, that if the BDLs themselves were used in the analysis wherever the analytical results were below BDL, the analysis conclusions would not change.

While this approach does not consider all waste constituents, it is considered appropriate for purposes of comparing potential remedies, since it addresses indicator constituents used in the risk assessment to make decisions regarding the site. Also, it is important to note that only limited TCLP data were available for this analysis. While additional data would change the absolute values of the total WSFs, the ratio which is used at the basis for comparison of potential alternatives, is likely to be relatively unaffected. Also, it is noted that the TCLP database used for the analysis in this SER is more extensive than the TCLP database used in the original FS and the same as the database used in the original remedial design.

Notwithstanding the results of the comparative analysis, it is essential to realize that the results of an analysis using TCLP data do not represent the characteristics of a potential release of constituents from the Bailey Superfund Site for the following reasons: (i) the TCLP test is designed to simulate the leaching of constituents from a waste under conditions that exist in a sanitary landfill (i.e., a condition where leachate is typically generated on a continuous or regular basis and where the leachate may be acidic; these conditions do not exist at the Bailey Superfund Site); and (ii) the TCLP test typically requires waste samples to be ground up into small particles to maximize constituent leachability. Furthermore, the risk assessment presented in the original RI concluded that "*most observations and analytical data did not suggest major impacts*" (under existing conditions). Thus, containment measures such as those proposed in either the ORD or PRA would improve the present situation, and therefore prevent "major impacts" of the type considered in the RI.

8.3.3 Assumptions Used for the Solidified Waste in the ORD

In the ORD model, the solidified waste is considered to be a single homogenous layer having an effective hydraulic conductivity of 1×10^{-6} cm/s. The solidified waste is also assumed to be incompressible.

The effective hydraulic conductivity of the solidified waste was selected on the basis of the specified performance requirement included in the ORD specifications. In reality, it is infeasible to obtain this hydraulic conductivity on an area-wide basis at the Bailey Superfund Site as evidenced by: (i) remedial actions previously conducted at the site have demonstrated the difficulties associated with achieving the specific hydraulic conductivity of 1×10^{-6} cm/s; (ii) studies performed by GeoSyntec indicate that the waste is not homogenous, and that major components of the waste mass are not amenable to effective in-situ solidification. Notwithstanding these comments, it is reasonable to use this value for the effective hydraulic conductivity in the analysis, as data show that the soils surrounding the waste have a low hydraulic conductivity. Hence, this effective hydraulic conductivity is considered appropriate for the waste and immediately adjacent subsurface soil.

The assumption that the solidified waste is incompressible is likely conservative (in the sense that the assumption results in less calculated migration from the ORD source than is likely to actually occur), since the solidification process would not render the waste completely incompressible, and some consolidation water would be produced from the solidified waste due to the imposed load of the overlying general fill and cap system.

8.3.4 Assumptions Used for the Unsolidified Waste in the PRA

In the PRA model, the waste is considered to be a single homogeneous layer. For the analysis of technical equivalency, the effective hydraulic conductivity of the unsolidified waste was assumed to be 1×10^{-6} cm/s. This value is consistent with hydraulic conductivities for unsolidified wastes reported in the SER.

Other sections of this FFSR present data that the waste is not homogenous and in fact contains a wide range of materials of different physical and chemical consistencies, strengths, moisture contents, and particle sizes. However, the assumption with regard to the effective hydraulic conductivity of the waste is considered reasonable, since data show that the soils surrounding the waste have a low hydraulic conductivity. Hence, this effective hydraulic conductivity is considered appropriate for the waste and immediately adjacent subsurface soils.

8.4 Evaluation of Liquid Sources

8.4.1 Ground-Water Flow

Information reported in the RI [WCC, 1987] concerning ground-water flow in the clay soils adjacent to and underlying the waste at the Bailey Superfund Site was used to evaluate the mechanism of outflow due to ground-water flow through the waste. Based on information in the RI, it is assumed that ground water is a negligible source for both the ORD and PRA. This conclusion is based on the fact that the wastes are essentially contained in-place by low hydraulic conductivity soils and the absence of a significant hydraulic gradient across the site. More specifically, since the ground-water volumetric flow rate is the product of hydraulic conductivity, hydraulic gradient, and area of the flow path, this assumption is therefore valid because: (i) the hydraulic conductivity values for soil samples collected from beneath and adjacent to the waste are in the range of 10^{-8} to 10^{-6} cm/s, with most values less than 2×10^{-7} cm/s (see Table 7-2); (ii) water levels around Pond A, as recorded by piezometers P-1 through P-14 in the RI, show no appreciable change in elevation when monitored during a tidal cycle [WCC, 1987]; and (iii) there is no evidence to suggest that an appreciable hydraulic gradient exists across the dikes that contain the wastes.

8.4.2 Infiltration Through Cap

The rate of infiltration through the cap system was evaluated for both the ORD and the PRA using the Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3. This model was developed by USEPA [Schroeder et al., 1984, 1994a, 1994b] for evaluation of the hydrology of landfills. The HELP model is a water balance method for evaluating runoff, evapotranspiration, infiltration (percolation), and lateral drainage for landfills. For this FFSR, computer simulations were performed using cross-sections and material properties developed for the ORD and the PRA.

Cross-Sections Used for Analyses

The cap systems for both the ORD and the PRA analyzed using the HELP model are shown in Figures 8-2 and 8-3, respectively. For the ORD, the components (from top to bottom) include:

- 0.5-ft (0.15-m) thick topsoil layer;
- 2.5-ft (0.76-m) thick compacted clay layer; and
- 2.0-ft (0.6-m) thick general fill layer.

For the PRA, the components (from top to bottom) include:

- 0.75-ft (0.23-m) thick protective cover soil layer;
- 0.2-in. (5.0-mm) thick geocomposite drainage layer;
- 60-mil (1.5-mm) thick high density polyethylene (HDPE) geomembrane;
- 0.25-in. (6-mm) thick geosynthetic clay liner (GCL); and
- 2.0-ft (0.6-m) thick general fill layer.

For each simulation, the slope of the cap system was assumed equal to 3 percent and the slope length was assumed equal to 75 ft (22.5 m). An average waste mass thickness of 5 ft (1.5 m) was also assumed for each simulation.

Material Properties

Table 8-1 presents a summary of the material properties of the cap system components and waste used for the HELP model analyses. Information from the technical specifications for the original remedial design [HLA, 1991b] was used to select suitable HELP model material properties for the topsoil/protective soil layer, compacted clay, and general fill layers. Values reported for the topsoil/protective soil layer are typical for surface soils suitable for grass growth. Values for compacted clay and general fill are typical for low-plasticity, compacted clayey soils. The values for the material properties of the geosynthetic components (i.e., geocomposite drainage layer, geomembrane, and GCL) reported in Table 8-1 were selected as default values from the HELP computer program. The properties for waste are average values based on data reported in the TM-NDA [GeoSyntec, 1995b], SER [HLA, 1991a], and original FS [Engineering-Science, 1988].

The evaluation of infiltration through the cap considered the effects of degradation of the single component cap under the climatic conditions occurring at the Bailey Superfund Site. The cap system selected for the ORD model includes two 15-in. (380-mm) thick layers of compacted clay, with the upper layer having an effective hydraulic conductivity of 1×10^{-6} cm/s and the lower layer having an effective hydraulic conductivity of 5×10^{-7} cm/s. These layers of clay are assumed to have effective hydraulic conductivities greater than the original design value of 1×10^{-7} cm/s for the reasons given below.

Due to the climatic conditions at the Bailey Superfund Site, the natural soil components of a cap system will be subjected to cycles of wetting and drying over the assumed 30-year post-closure period. Laboratory and field studies have shown that desiccation cracking and subsequent increases in hydraulic conductivity will almost certainly occur for low hydraulic conductivity soil (clay) layers not adequately protected from environmental stresses, such as cycles of wetting and drying. As presented in *"Design and Construction of RCRA/CERCLA Final Covers"* [USEPA, 1991], there are two ways to provide the required protection of a low hydraulic conductivity soil layer in a capping system. The first is to *"bury the liner (clay layer) beneath an adequate depth of soil overburden"*, and the second is to *"place a geomembrane over the soil"*. The cap for the ORD is comprised of a 30-in. (76-cm) thick compacted clay layer overlain by a 6-in. (15-cm) thick topsoil layer. This topsoil layer does not provide adequate protection of the compacted clay layer and degradation of the clay layer in the form of an increase in the hydraulic conductivity would most likely occur. In addition, it is unlikely that an inspection and maintenance program could fully prevent the degradation of the capping system for the ORD. Repair of visually detected cracks would likely not return the cap to its original condition without placing a geomembrane or more protective cover soil over the low hydraulic conductivity soil layer.

In recent years, various researchers and institutions have performed laboratory and field investigations to examine the influence of desiccation cracking on the apparent increase in hydraulic conductivity of compacted clay soils. This research has been motivated by industry and regulatory concerns regarding the increase in hydraulic conductivity of compacted clays when used in a cap system. For example, in tests performed by Boynton and Daniel [1985], 2.5-in. (64-mm) thick slabs of a high-plasticity clay were compacted and then allowed to dry. Cracks were observed that penetrated the full depths of the slabs in less than 24 hours. Results indicated that the hydraulic conductivity increased by approximately one order of magnitude for desiccated samples which were subjected to confining pressures not greater than 420 psf (20 kPa). As another example, Benson and Othman [1992] examined the effects of the number of dry/wet cycles on the hydraulic conductivity of laboratory compacted low-plasticity clays. The hydraulic conductivity increased as the number of dry/wet cycles increased. The increase in hydraulic conductivity was approximately two orders of magnitude after the first cycle and three orders of magnitude after the second cycle. Examination of the clay samples indicated that large continuous cracks propagated the entire length of the samples.

Montgomery and Parsons [1990] presented performance data on three cap system test plots at a landfill located near Milwaukee, Wisconsin. Each test plot was subjected to a drought followed by a period of heavy rainfall. Two of the three test plots had a 6- to 18-in. (150- to 450-mm) thick topsoil layer overlying a 48-in. (1220-mm) thick compacted clay layer. Large cracks 0.25 to 0.5 in. (6.4 to 12.7 mm) wide that extended to depths of 35 to 40 in. (890 to 1020 mm) into the cap system were observed. They found that cracks controlled the hydraulic conductivity of the clay cap system and that the field hydraulic conductivity exceeded the laboratory measured values by more than one order of magnitude. Data indicated that four years after construction, the magnitude of percolation through each of the two cap systems had increased from an initial average value of 0.5 percent of precipitation (after one year following construction) to an average of nine percent of precipitation. This 18-fold increase in percolation was attributed to desiccation cracks which extended 35 to 40 in. (90 to 100 cm) into the clay layer.

The third test plot consisted of two 24-in. (610-mm) thick compacted clay layers with a 12-in. (300-mm) sand layer in between. Six in. (150 mm) of topsoil was placed on top of the upper clay layer. For this test plot, percolation through the bottom clay layer remained approximately constant at a magnitude equal to four percent of the precipitation for the four year period following construction. However, the upper clay/topsoil unit allowed substantial percolation of moisture into the upper sand layer. Discharge from the upper sand layer occurred only hours after the start of a precipitation event suggesting rapid movement of water through the upper clay due to flow through cracks.

It is noted that large overburden stresses which may exist on a compacted clay liner can close pre-existing cracks and prevent the development of new cracks [Daniel and Wu, 1993]. The overburden stress acting on a compacted clay cap is typically not sufficient to close cracks. The overburden stress on the single component cap for the ORD would be approximately 60 psf (2.9 kPa) which corresponds to a topsoil thickness of 0.5 ft (0.15 m).

The technical specifications for the ORD [HLA, 1991b] indicate that the compacted clay cap "*is to have a demonstrated permeability equal to or less than* 1×10^{-7} *cm/s*" at the time of construction. The technical specifications for the ORD do not require a geomembrane over the clay (which would serve as a vapor barrier) and only require a 6-in. (0.15-m) thick soil cover over the clay. Based on this information, and the studies cited above, it is appropriate to assume that the hydraulic conductivity of the compacted clay will increase during the post-closure period as a result of environmental stresses, principally cycles of wetting and drying.

In the opinion of GeoSyntec, the entire 2.5 ft. (760 mm) thickness of compacted clay cap will be affected to at least some degree by environmental stresses, principally cycles of wetting and drying. To account for the potential effects of cycles of wetting and drying on the ORD cap system, the 2.5-ft (760-mm) thick compacted clay layer was modeled as two sublayers of equal thickness and differing hydraulic conductivity. The upper sublayer, which extends downward from the bottom of the topsoil layer, is considered to have been subjected to cycles of wetting and drying and was assigned an effective hydraulic conductivity of 1 x 10^{-6} cm/s (i.e., one order of magnitude greater than the hydraulic conductivity required by the construction specifications). The lower sublayer is assumed to have a hydraulic conductivity of 5 x 10^{-7} cm/s.

For a well-designed and installed composite cap, the frequency of holes in the geomembrane was assumed to be one hole per acre (1 hole per 4,000 m^2) [Giroud and Bonaparte, 1989]. The default hole size used by the HELP model has an area of 0.16 $in.^2$ (100 mm^2), which corresponds to a standard geomembrane hole size recommended by Giroud and Bonaparte [1989] for calculations conducted to evaluate liner performance and leakage rates. The holes, if circular, would have corresponding diameters of approximately 0.45 in. (11.5 mm). The geomembrane placement quality (i.e., contact with underlying soil) was assumed to be good. A good geomembrane placement quality assumes a *"field installation with well-prepared, smooth soil surface and geomembrane wrinkle control to insure good contact between geomembrane and adjacent soil that limits drainage rate"* [Schroeder et al., 1994a].

Climatological Data

Precipitation and temperature data which has been compiled for Port Arthur, Texas [NOAA, 1987] were used for each analysis. Monthly average precipitation data reported in NOAA [1987] were used as input to the HELP model and an average annual precipitation of 51.32 in. (1300 mm) was calculated by the HELP model. Other required climatological data were generated synthetically by the HELP computer program. The analyses were performed for an assumed post-closure period of 30 years.

Summary of HELP Model Simulations

The HELP model was used to calculate infiltration rates and volumes through the ORD and PRA cap systems. The results of the HELP model analyses for each simulation are shown in Table 8-2. Computer output for each of these simulations is provided in Appendix D. The model simulations result in essentially no infiltration through the PRA lightweight composite cap and an average of 2.2 in. (56 mm) of infiltration annually through the ORD single component cap.

8.4.3 Consolidation of Waste

A model based on the theory of one-dimensional primary consolidation of clay soils was used to evaluate source liquid generation due to consolidation of the waste resulting from the weight of the cap systems. Herein, this source is referred to as "consolidation water." For this model, the settlement of the waste layer was calculated and simple mass-volume phase relationships were used to convert the settlement into an equivalent volume of consolidation water.

The material properties of the waste influence the calculated magnitude of waste consolidation. The waste at the Bailey Superfund Site is variable (waste types include MSW, rubber crumb, and a mixture of MSW, rubber crumb, and soil). For this reason, material properties were developed for each of the predominant waste types found at the Bailey Superfund Site and separate calculations of the magnitude of waste consolidation were performed. The variability of the waste made it necessary to perform separate technical equivalency analyses for each predominant waste type.

Procedure to Calculate Consolidation Water

A three-step procedure was used to calculate consolidation water for the PRA. This procedure is outlined below.

Step 1. For each waste type, an idealized stratigraphy was developed which consisted of a vertical column of waste overlain by the cap system. The material properties of the waste required for the analysis were evaluated. This evaluation is discussed subsequently.

Step 2. The settlement of the waste layer was evaluated according to the equation for primary settlement of a normally consolidated clay [e.g., Holtz and Kovacs, 1981]:

$$S_t = C_{CE} H \ \log\left(\frac{\sigma' + \Delta\sigma}{\sigma'}\right) \qquad \textbf{(Equation 8-2)}$$

where S_t = total primary settlement of the waste layer; C_{CE} = modified primary compression index; H = height of the waste layer; σ' = initial (before cap system construction) vertical effective stress at the mid-depth of the waste layer; and $\Delta\sigma$ = additional stress imposed by the weight of the general fill used for grading and the components of the cap system. Basic English units are: S_t (ft), C_{CE} (dimensionless), H (ft), σ' (psf), and $\Delta\sigma$ (psf). Basic SI units are: S_t (m), C_{CE} (dimensionless), H (m), σ' (kPa), and $\Delta\sigma$ (kPa). This equation has been used elsewhere to evaluate settlements of waste in MSW landfills [e.g., Fassett et al., 1994]. The actual analysis subdivides the waste mass into several layers, and the settlements from each layer are summed together to evaluate the total primary settlement of the waste layer.

Step 3. The calculated settlement of each waste layer was converted into an equivalent volume of consolidation water using mass-volume phase relationships. A detailed derivation for the volume of consolidation water is provided in Appendix E.

The consolidation water from a waste layer depends on the degree of saturation of the layer and the calculated magnitude of the settlement of the layer. The following two conditions were considered in this step of the analysis: (i) if the waste layer is fully saturated (S_r = 100 percent), all of the calculated settlement of the waste layer is assumed to be effective in producing consolidation water; (ii) if the waste layer is not saturated (S_r< 100 percent), then only a portion of the settlement of the waste layer is assumed to be effective in producing consolidation water. The physical significance of the second condition is that if a load is placed on unsaturated waste, a reduction in air void space (i.e., compaction) will occur. By using the phase relationship developed in Appendix E, the magnitude of settlement required to reduce the air void space to zero in an initially unsaturated waste layer can be evaluated. If this settlement is greater than that calculated from Equation 8-2, then no consolidation water will be produced; if it is less than that calculated from Equation 8-2, then consolidation water will be produced.

Cross-Sections Analyzed

Based on a review of available information for the Bailey Superfund Site, three idealized cross-sections were developed which correspond to the three predominant waste types found at the Bailey Superfund Site. The three waste types are: (i) MSW; (ii) rubber crumb; and (iii) a mixture of MSW, rubber crumb, and soil.

For each cross-section, a 6-ft (1.8-m) thick layer of waste was assumed. This represents a reasonable average for the waste thickness at the Bailey Superfund Site as waste thicknesses have been observed from 0 to 12 ft (0 to 3.6 m). It was also assumed that the waste is saturated for the bottom 3 ft (0.9 m) of the 6 ft (1.8 m) thickness. This assumption is based on test pit information in the North Dike Area wastes reported in TM-NDA [GeoSyntec, 1995b]. In several test pits in the North Dike Area, saturated wastes and pockets of perched water were evident at mid-depth of the test pits.

Material Properties

Material properties for the settlement and consolidation water analyses performed in this section are summarized in Table 8-3. The material properties for the three waste types are based primarily on results from the TM-NDA [GeoSyntec, 1995b] and from the SER [HLA, 1991a]. Based on the waste composition data from these investigations, estimates of the specific gravity of the waste materials were made. Using estimated values for total unit weight and moisture content, values for void ratio and degree of saturation of the waste materials were calculated. These calculations were performed using mass-volume relationships developed for soils. Modified primary compression indices for the various wastes were based on GeoSyntec project experience, engineering judgment, and reported values in the literature [e.g., Fassett et al., 1994; Michalski et al., 1995].

Summary of Evaluation of Consolidation Water

The results of the analysis of consolidation water is provided in Table 8-4. The consolidation water volumes produced are given in terms of "height of water" since the problem analyzed is one-dimensional. The magnitude of consolidation water was evaluated for three cases. The analyses performed employed the cap system for the PRA and each of the three cross-sections corresponding to the three waste types. Since no data exists on the compressibility characteristics of solidified waste at the Bailey Superfund Site, it was conservatively assumed that zero consolidation water would be produced resulting from the weight of the general fill and cap system for the ORD. It was also assumed that all consolidation water was produced at the beginning of the first year (i.e., during placement of the general fill layer). This assumption is based on: (i) results of the Sitewide Pre-design Study presented in Section 8.5 of this FFSR; and

(ii) field measured settlements of waste that indicate that primary settlement of waste occurs during a relatively short period of time as compared to typical clay soils [Boutwell and Fiore, 1995; Michalski ėt al., 1995].

8.4.4 Removal of Consolidation Water

A consolidation water collection and removal system was retained as a potential process option to enhance the performance of a capping system. If implemented, the consolidation water collection system would be designed to collect, remove, treat, and dispose of liquids resulting from consolidation effects. As previously stated, consolidation effects influence short-term conditions only. Therefore, the results of the equivalency demonstration can be influenced by the collection and removal of a lesser or greater amount of liquid during construction of the remedy. For the analysis of technical equivalency, the volume removed by the consolidation water collection system is assumed to be equal to the volume of consolidation water.

8.4.5 Evaluation of Net Outflow

The net outflow of liquid from the waste mass (Q_n) due to the source mechanisms discussed in Sections 8.4.1 through 8.4.4 of this report was calculated using the equation presented in Figure 8-1 and given below:

$$Q_n = Q_i + Q_g + Q_c - Q_r \qquad \textbf{(Equation 8-3)}$$

where Q_i = volume of liquid resulting from infiltration through the cap system; Q_g = volume of liquid due to ground-water inflow; Q_c = volume of consolidation water and Q_r = volume of liquid removed by the consolidation water collection system. Since a one-dimensional model was used, basic English units are: Q_n (in.), Q_i (in.), Q_g (in.), Q_c (in.); and Q_r.(in.). Basic SI units are Q_n (mm), Q_i (mm), Q_g (mm), Q_c (mm); and Q_r (mm).

As previously stated, it was conservatively assumed that zero consolidation water would be produced by the ORD cap (since the solidified waste is assumed to incompressible). Since ground-water flow is also considered to be a negligible source, the only source of liquid for the ORD model is infiltration through the cap.

For the PRA, the ground-water flow is assumed to be a negligible source, and, as previously stated, the volume of infiltration through the cap is essentially zero. In the case of the PRA, the only source of liquid is that due to consolidation water.

Figure 8-4 shows time histories of net outflow for the ORD and the PRA calculated using the methodology described above. The time histories cover the 30-year post-closure period. The volume of liquid is reported in terms of the height of a column of water, since the mathematical model used in the calculations is based on a one-dimensional formulation. The single curve for the ORD reflects the volume of liquid infiltrating through the cap system only (since it was assumed that this remedy would not induce the generation of consolidation water (see Table 8-4). As presented in Figure 8-4, the rate of net outflow (represented by the slope of the curve) for the ORD is relatively constant (i.e. the slope of the net outflow versus time curve is essentially a straight line). The three curves for the PRA essentially reflect the contribution to net outflow of consolidation water, which only occurs at the beginning of the first year, and outflow related to cap system infiltration, which is essentially zero for the 30-year simulation period. The curve for the PRA incorporating the CWCS (consolidation water collection system) represents the effect on net outflow of providing a system to collect and remove consolidation water generated during the construction of the PRA. As shown by this curve, if the consolidation water collection system is implemented as an enhancement to the lightweight composite cap, the net outflow is easily reduced to essentially zero. As shown in Section 8.5 which follows, if the net outflow is essentially zero, the total weighted source flux becomes zero.

The average daily net outflow were calculated for the ORD, PRA, and PRA incorporating the CWCS. The results of this calculation are presented in Table 8-5. As shown in this table, the average daily net outflow for the ORD is approximately 161 gal/acre-day (1,505 l/hectare-day) for the 30-year simulation period. The average daily net outflow for the PRA ranges from 208 to 305 gal/acre-day (1,950 to 2,850 l/hectare-day) for the first year. The average daily net outflow from the PRA for years one through 30 decreases to zero. This decrease in average daily net outflow for the PRA is attributed to the completion of waste consolidation before the end of the first year (i.e., liquid production from waste consolidation should occur at the beginning of the first year). The average daily net outflow for the PRA incorporating the CWCS is zero for all years.

The results of the evaluation of net outflow are used in the following subsection to calculate the total WSF for both the ORD and PRA.

8.5 Comparison of Total Weighted Source Flux

In this section, the analysis of technical equivalency for the two alternatives is performed. The information and data presented in Section 8.3 provides net outflow, Q_n, for both the ORD and PRA. Herein, the TCLP results for each indicator chemical, C_O, for both the solidified (ORD) and unsolidified (PRA) waste are presented. The total WSF was calculated using those indicator chemicals used in the baseline risk assessment that have associated TCLP data and toxicity constants. Indicator chemicals used are: (i) arsenic; (ii) benzene; (iii) ethylbenzene; (iv) lead; and (v) trichloroethylene.

The results of the analysis of technical equivalency are presented in Tables 8-6 and 8-7 for two of the three predominant waste types at the Bailey Superfund Site (i.e., rubber crumb and MSW/rubber crumb/soil). No TCLP data are available for MSW only; since MSW only should not contain significant concentrations of indicator chemicals, equivalency is established on the basis of net outflow (Q_n) only. The WSF for a given indicator chemical is the product of the total volume of net outflow for a 30-year period, the representative TCLP concentration of the indicator chemical in the specific waste type (C_O), and the maximum toxicity constant for water, T_C. The representative TCLP result for each indicator chemical for each type is taken as the average concentration for the relevant individual test results. The total WSF is the sum of the WSFs for each of the indicator chemicals, and is a relative measure of the source contaminant performance of each alternative.

The relative performance ratio reported in Tables 8-6 and 8-7 is defined as the ratio of the total WSF for the PRA divided by the total WSF for the ORD. A relative performance ratio is calculated for each waste type. A relative performance ratio less than unity indicates that technical equivalency is achieved, and that the source containment capabilities of the PRA are superior to those of the ORD for the specific waste type. Tables 8-6 and 8-7 indicate that the relative performance ratio is less than unity for all considered cases, indicating that technical equivalency is achieved. It can also be concluded through review of these tables that the technical superiority of the PRA over the ORD can be maximized by including the consolidation water collection system process option as a component of the PRA. Operation of such a system during the construction phase of the remedy will result in the PRA providing superior performance to the ORD in the short term.

Figures 8-5 and 8-6 show time histories of total WSF rate and cumulative total WSF for rubber crumb waste and MSW/rubber crumb/soil waste, respectively. Each time history plot provides a relative measure of the source containment capabilities of the ORD and PRA. A discussion of the two time histories is presented below.

Rubber Crumb

Without the inclusion of a consolidation water collection and removal system, the ORD provides superior performance to the PRA for the first year. It is reiterated, however, that the performance of both the ORD and PRA during this period is superior to the current performance of the waste source. Also, it is evident that during this initial year, performance of the PRA is dominated by waste consolidation effects. If the consolidation water is collected and removed during construction, the performance of the PRA is improved to the point where the performance of the PRA always exceeds that of the ORD, as evidenced by the time history plot for the PRA incorporating the CWCS (i.e., it considers infiltration only). The time history plots clearly indicate the superior performance of the lightweight cap component of the PRA after consolidation has occurred when compared to the ORD. This is evident by the source flux rate of essentially zero for the PRA in Figure 8-5. The cumulative effect is that the PRA provides far superior performance to the ORD during the anticipated post-closure period.

MSW/Rubber Crumb/Soil

Without the inclusion of a consolidation water collection and removal system, the ORD provides superior performance to the PRA for years 1 through 2. It is reiterated, however, that the performance of both the ORD and PRA during these years is superior to the current performance of the source. Similar to the rubber crumb waste type, it is evident that during the initial years, performance of the PRA tends to be dominated by waste consolidation effects. If consolidation water is collected and removed during construction, the performance of the PRA is improved to the point where the performance of the PRA always exceeds that of the ORD, as evidenced by the time history plot for the PRA incorporating the CWCS (Figure 8-6). The cumulative effect is that the PRA provides superior performance to the ORD during the anticipated post-closure period.

Collection of Consolidation Water

As predicted by the consolidation analyses, waste consolidation will occur during the first year for the PRA and should be essentially complete after that time. A consolidation water collection and removal system was retained from the secondary screening of process options (Section 7). This process option was retained as a potential remedy enhancement to the capping remedy. The analysis of technical equivalency indicates that the inclusion of this process option in the final remedy will improve the short-term performance of the PRA to the point where it exceeds the performance of the ORD at all times during the anticipated life of the remedy.

Due to the relatively low hydraulic conductivity of the marsh soils that underlie waste at the Bailey Superfund Site, consolidation water will tend to move in an upward direction towards the ground surface and occupy any remaining void space within the waste mass. This liquid will, therefore be largely contained in place and can easily be collected and removed during the construction period using conventional means. The collected liquids can be treated on site and discharged subject to meeting current treatment standards established for this site. This procedure would eliminate and short-term increase in risk otherwise associated with the implementation of the PRA.

To evaluate the consolidation of the unsolidified waste and feasibility of collecting consolidation water during the construction period, a Sitewide Pre-design Study (SPDS) was performed at the Bailey Superfund Site in April and May 1996. The primary components of the SPDS included the following field activities: (i) construction of five consolidation test pads which applied an equal or greater bearing stress to the waste than will the lightweight composite cap; (ii) installation of piezometers at two of the test pads; and (iii) monitoring of ground-surface and ground-water elevation changes. The field activities associated with this work are complete, but the technical memorandum presenting the findings is not. However, a brief summary of the findings is provided below:

- all five test pads exhibited a high degree of stability;
- average amount of consolidation for the five test pads during the evaluation period was 3.24 in. (82.3 mm);
- the rate of consolidation rapidly decreases with time; and
- there were short-term (i.e. during the first several days) measurable rises of the ground-water elevation within the piezometers.

Therefore, by constructing a consolidation water collection system at or slightly above the ground-water table and sequencing construction and surface-water management activities, migrating consolidation water can be intercepted and directed to an on-site treatment system prior to discharge, consistent with existing site procedures.

Summary

Based on the information presented in this section, the long-term performance of the PRA is equivalent or superior to the ORD in terms of source control. The short-term performance of the PRA is also superior to the ORD for all areas, assuming that a consolidation water collection system is installed within the upper portion of the waste mass, construction is properly sequenced, and existing surface-water management measures are continued during implementation of the PRA.

TABLE 8-1
SUMMARY OF MATERIAL PROPERTIES USED IN HELP MODEL SIMULATIONS BAILEY SUPERFUND SITE ORANGE COUNTY, TEXAS

Component	Total Porosity (vol/vol)	Field Capacity (vol/vol)	Initial Water Content (vol/vol)	Wilting Point (vol/vol)	Effective Hydraulic Conductivity (cm/s)
Protective Soil	0.463	0.232	0.232	0.116	3.7×10^{-4}
Clay	0.437	0.373	0.373	0.266	1×10^{-6} and 5×10^{-7} (1)
General Fill	0.437	0.373	0.373	0.266	3.6×10^{-6}
Geocomposite Drainage Layer	0.850	0.010	0.005	0.005	10
Geomembrane	0.000	0.000	0.000	0.000	2×10^{-13}
Geosynthetic Clay Liner (GCL)	0.750	0.747	0.750	0.400	3×10^{-9}
Solidified Waste	0.540	0.430	0.430	0.200	1×10^{-6}
Unsolidified Waste	0.520	0.430	0.430	0.200	1×10^{-6}

(1) Effective hydraulic conductivity of upper 15 in. (380 mm) was 1×10^{-6} cm/s and an effective hydraulic conductivity of 5×10^{-7} cm/s was used for the lower 15 in. (380 mm).

TABLE 8-2
SUMMARY OF HELP MODEL SIMULATIONS
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Simulation	Average Annual (in.)				
	Precipitation	Runoff	Evapotranspiration	Lateral Drainage	Infiltration Through Cap
Original Remedial Design (ORD)	51.32	14.003	35.079	0.000	2.167
Potential Remedial Alternative (PRA)	51.32	1.516	28.833	20.965	0.000

TABLE 8-3
SUMMARY OF MATERIAL PROPERTIES USED IN EVALUATION OF WASTE CONSOLIDATION SOURCE
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Material Type	Total Unit Weight(1) (pcf)	Water Content(1) (%)	Specific Gravity(1) (-)	Void Ratio(1) (-)	Degree of Saturation(1) (%)	Modified Primary Compression Index(1)
MSW	72	39	1.82	1.19	60	0.20
Rubber Crumb	68	53	1.62	1.22	76	0.20
MSW/Rubber Crumb/Soil	82	52	2.03	1.42	78	0.20
Topsoil	120(2)	N/A	N/A	N/A	N/A	N/A
Compacted Clay	130(2)	N/A	N/A	N/A	N/A	N/A
General Fill	130(2)	N/A	N/A	N/A	N/A	N/A

(1) Parameter value listed as N/A implies that an estimate of this parameter was not necessary for the analysis.
(2) Total unit weights of each component are used to calculate $\Delta\sigma$ (Equation 8-2).

TABLE 8-4
SUMMARY OF OUTFLOW FROM WASTE CONSOLIDATION SOURCE
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Waste Type	Height of Water (in.)	
	Original Remedial Design (ORD)[1]	Potential Remedial Alternative (PRA)
MSW	0.0	2.808
Rubber Crumb	0.0	4.116
MSW/Rubber Crumb/Soil	0.0	3.480

[1] It was assumed that solidified waste produced no consolidation water.

TABLE 8-5
SUMMARY OF DAILY AVERAGE NET OUTFLOW
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Yearly Period (yr)	Average Daily Net Outflow (gal/acre-day)				
		PRA			
	ORD	MSW	Rubber Crumb	MSW/Rubber Crumb/Soil	PRA Incorporating CWCS
0 through 1	161	209	306	259	0
1 through 30	161	0	0	0	0

TABLE 8-6
ANALYSIS OF TECHNICAL EQUIVALENCY - RUBBER CRUMB
BAILEY SUPERFUND SITE, ORANGE COUNTY, TEXAS

		Original Remedial Design (ORD)				Potential Remedial Alternative (PRA)					
Indicator Chemical	Maximum Toxicity Constant for Water[1] (l/mg)	Q_n for 30 Years (in.)	Replicate Solidified Waste TCLP Results (mg/l)	Average Solidified Waste TCLP Result[2] (mg/l)	Weighted Source Flux (in.)	Q_n for 30 Years (in.) (PRA only)	Total Q_n for 30 Years (in.) (PRA Incorporating CWCS)[3]	Replicate Unsolidified Waste TCLP Results (mg/l)	Average Unsolidified Waste TCLP Result[2] (mg/l)	Weighted Source Flux for Q_n (in.) (PRA only)	Weighted Source Flux for Q_n (in.) (PRA Incorporating CWCS)
Arsenic	4.07	65.004	BDL (0.039) BDL (0.039) BDL (0.039)	BDL (0)	0.00	4.116	0.0	BDL (0.006) 0.008 0.011	0.006 BDL (0)	0.10	0.0
Benzene	0.17	65.004	2.1 6.5 BDL (48)	2.87 BDL (0)	31.72	4.116	0.0	BDL (47.5) BDL (1.25) BDL (2.4)	BDL (0)	0.00	0.0
Ethylbenzene	0.011	65.004	5900 330 1100	2,443	1,746.85	4.116	0.0	380 BDL (1.25) 1700	693 BDL (0)	31.38	0.0
Lead	0.893	65.004	BDL (0.031) BDL (0.031) BDL (0.031)	BDL (0)	0.00	4.116	0.0	0.12 0.023 0.015	0.053	0.19	0.0
Trichloroethylene	1.05	65.004	BDL (3.4) BDL (15.5) BDL (48)	BDL (0)	0.00	4.116	0.0	BDL (47.5) BDL (1.25) BDL (2.4)	BDL (0)	0.00	0.0
Total Weighted Source Flux (WSF)					**1,778.57**					**31.67**	**0.0**
Relative Performance Ratio[4]										**0.02**	**0.0**

[1] Values reported for maximum toxicity constant for water are taken from Table R-2 from the RI.

[2] Values reported for average solidified and unsolidified TCLP result are taken from the SER. BDL = Below Detection Limits.

[3] CWCS=Consolidation water collection system,

[4] The relative performance ratio is the ratio of the PRA total WSF to the ORD total WSF. A relative performance ratio less than 1.0 implies better source containment for the PRA compared to the ORD.

TABLE 8-1
ANALYSIS OF TECHNICAL EQUIVALENCY - MSW/RUBBER CRUMB/SOIL
BAILEY SUPERFUND SITE, ORANGE COUNTY, TEXAS

		Original Remedial Design (ORD)				Potential Remedial Alternative (PRA)					
Indicator Chemical	Maximum Toxicity Constant for Water(1) (l/mg)	Q_n for 30 Years (in.)	Replicate Solidified Waste TCLP Results (mg/l)	Average Solidified Waste TCLP Result(2) (mg/l)	Weighted Source Flux (in.)	Q_n for 30 Years (in.) (PRA only)	Total Q_n for 30 Years (in.) (PRA Incorporating CWCS) (3)	Replicate Unsolidified Waste TCLP Results (mg/l)	Average Unsolidified Waste TCLP Result (2) (mg/l)	Weighted Source Flux for Q_n (in.) (PRA only)	Weighted Source Flux for Q_n (in.) (PRA Incorporating CWCS)
Arsenic	4.07	65.004	BDL (0.039) BDL (0.039) BDL (0.039)	BDL (0)	0.00	3.480	0.0	0.021 0.014 0.006	0.014	0.20	0.0
Benzene	0.17	65.004	BDL (4.6) 0.34 29	9.78 BDL (0)	108.08	3.480	0.0	42 BDL (90) 26	22.7 BDL (0)	13.43	0.0
Ethylbenzene	0.011	65.004	160 1.1 490	217	155.16	3.480	0.0	1300 1300 730	1,110	42.49	0.0
Lead	0.893	65.004	BDL (0.031) BDL (0.031) BDL (0.031)	BDL (0)	0.00	3.480	0.0	0.074 0.15 0.029	0.084	0.26	0.0
Trichloroethylene	1.05	65.004	BDL (4.6) BDL (0.033) BDL (45.5)	BDL (0)	0.00	3.480	0.0	8.4 BDL (90) BDL (1.8)	2.8 BDL (0)	10.23	0.0
Total Weighted Source Flux (WSF)					**263.24**					**66.61**	**0.0**
									Relative Performance Ratio(4)	**0.25**	**0.0**

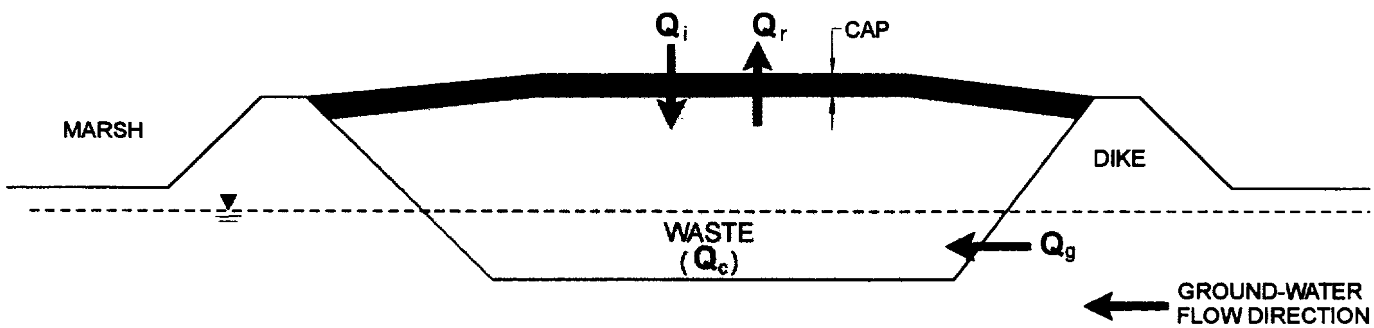
(1) Values reported for maximum toxicity constant for water are taken from Table R-2 from the RI.

(2) Values reported for average solidified and unsolidified TCLP result are taken from the SER. BDL = Below Detection Limits.

(3) CWCS=Consolidation water collection system,

(4) The relative performance ratio is the ratio of the PRA total WSF to the ORD total WSF. A relative performance ratio less than 1.0 implies better source containment for the PRA compared to the ORD.

CONCEPTUAL WATER BALANCE MODEL
ANALYSIS OF TECHNICAL EQUIVALENCY



INFLOW AND CONSOLIDATION WATER (Q_{in})

$$Q_{in} = Q_i + Q_g + Q_c$$

Q_i = infiltration through cap

Q_g = ground-water inflow

Q_c = consolidation water

OUTFLOW AND WATER REMOVAL (Q_{out})

$$Q_{out} = Q_n + Q_r$$

Q_n = net outflow

Q_r = water collected and removed by engineered system

NET OUTFLOW

$$Q_n = Q_i + Q_g + Q_c - Q_r$$

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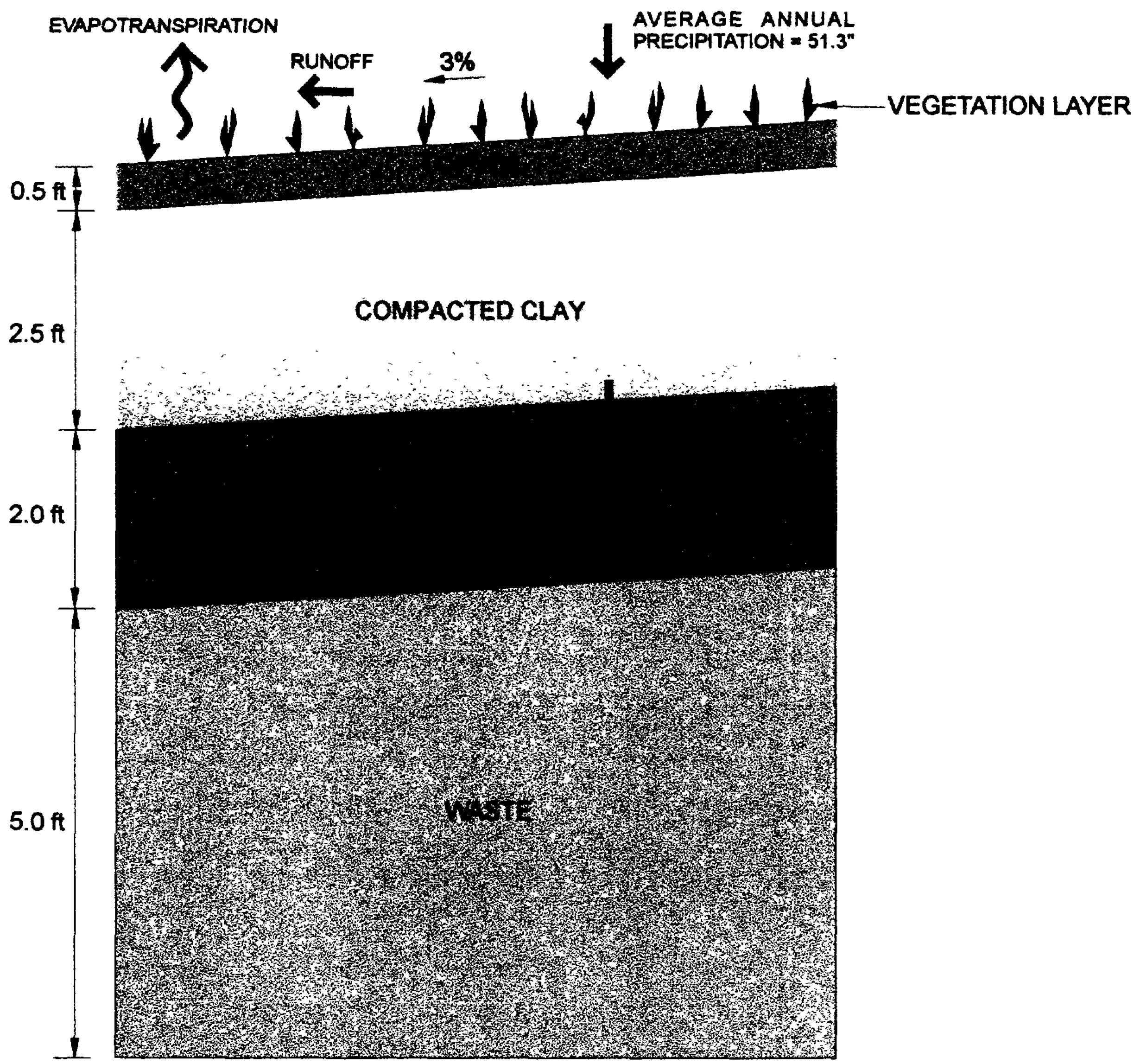
FIGURE NO.	8 - 1
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	QQQ.CDR

ORIGINAL REMEDIAL DESIGN
SINGLE COMPONENT CAP
(AS-DESIGNED CONDITION)



GEOSYNTEC CONSULTANTS
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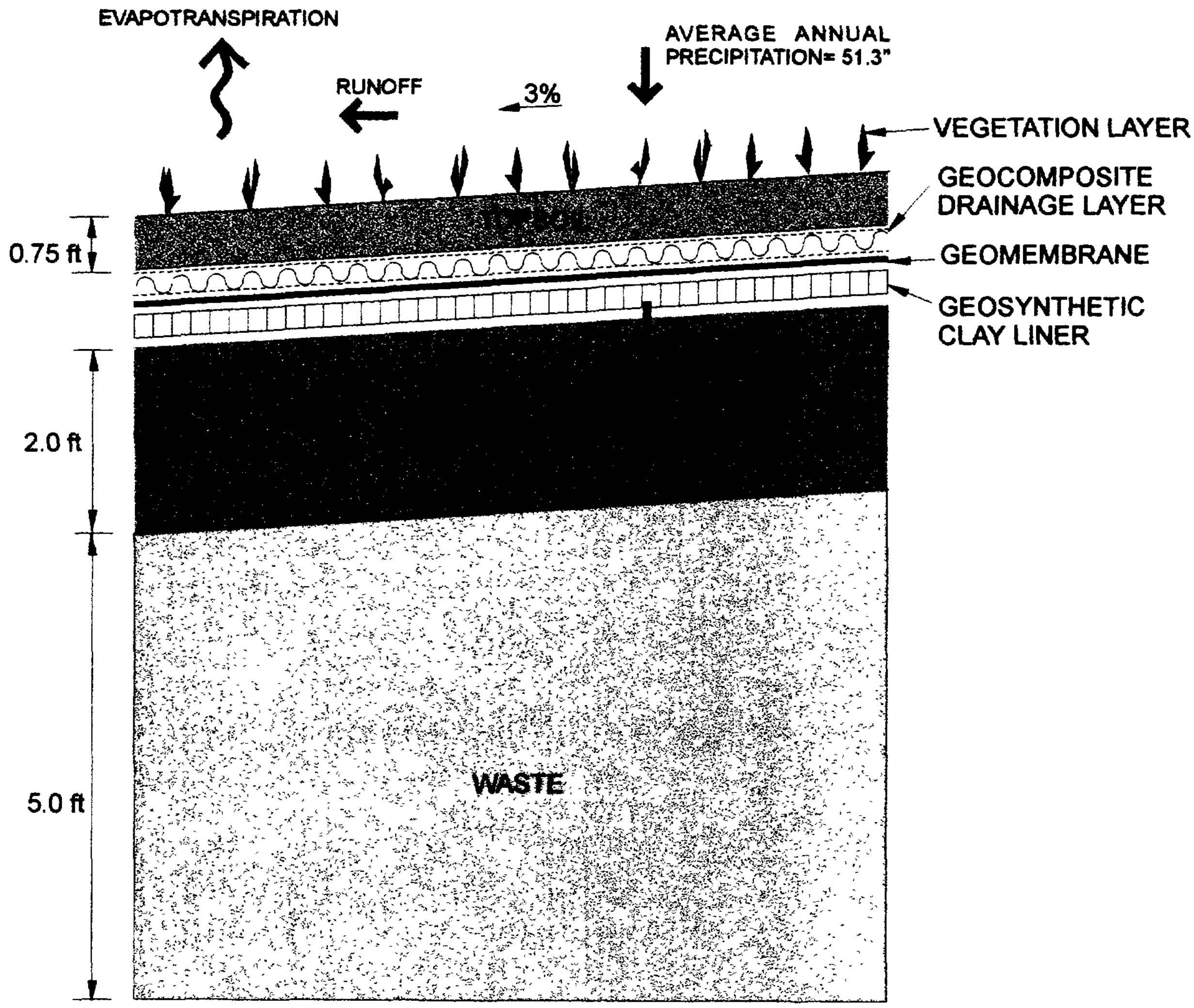
FIGURE NO.	8 - 2
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	OR-REM1.CDR

POTENTIAL REMEDIAL ALTERNATIVE
LIGHTWEIGHT COMPOSITE CAP



GeoSyntec Consultants
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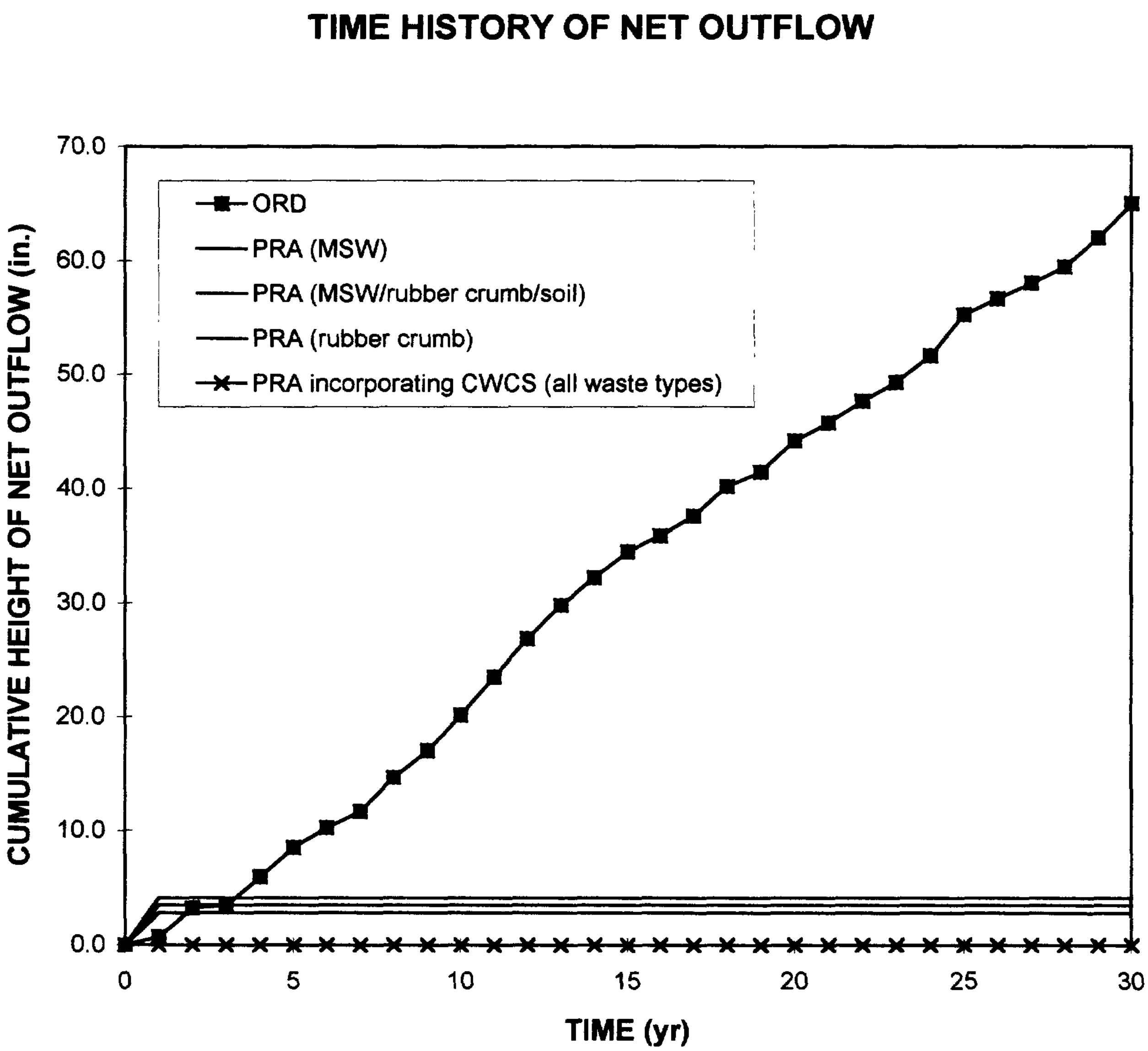
FIGURE NO.	8 - 3
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	PROP-RE1.CDR

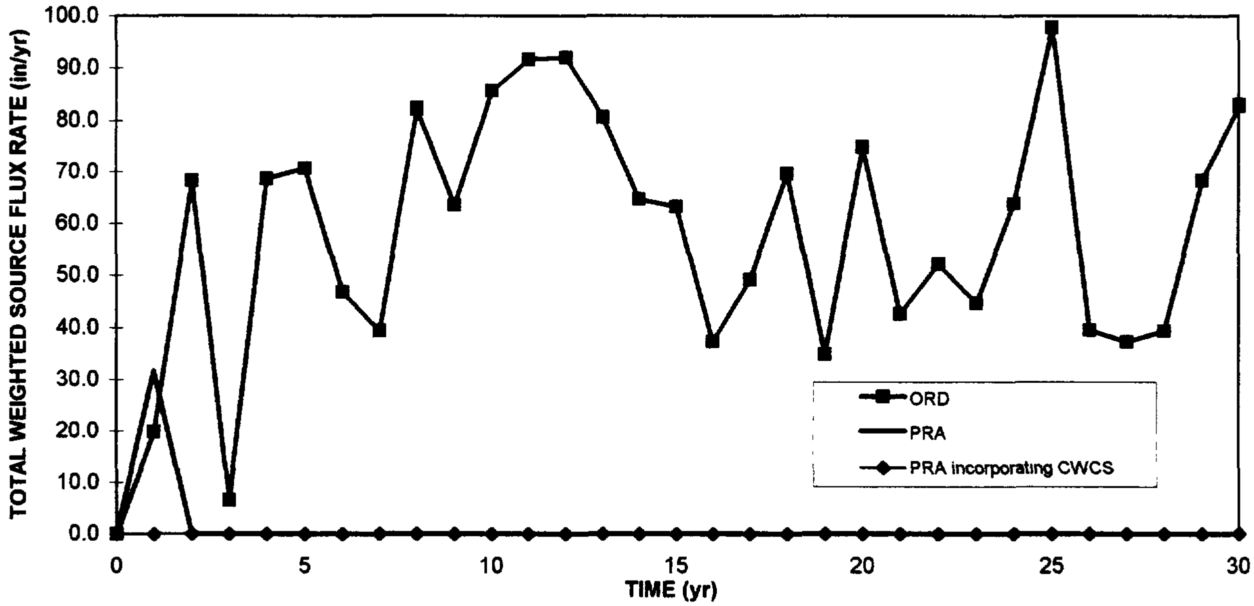


Notes:
ORD = Original Remedial Design
PRA = Potential Remedial Alternative
CWCS = Consolidation Water Collection System

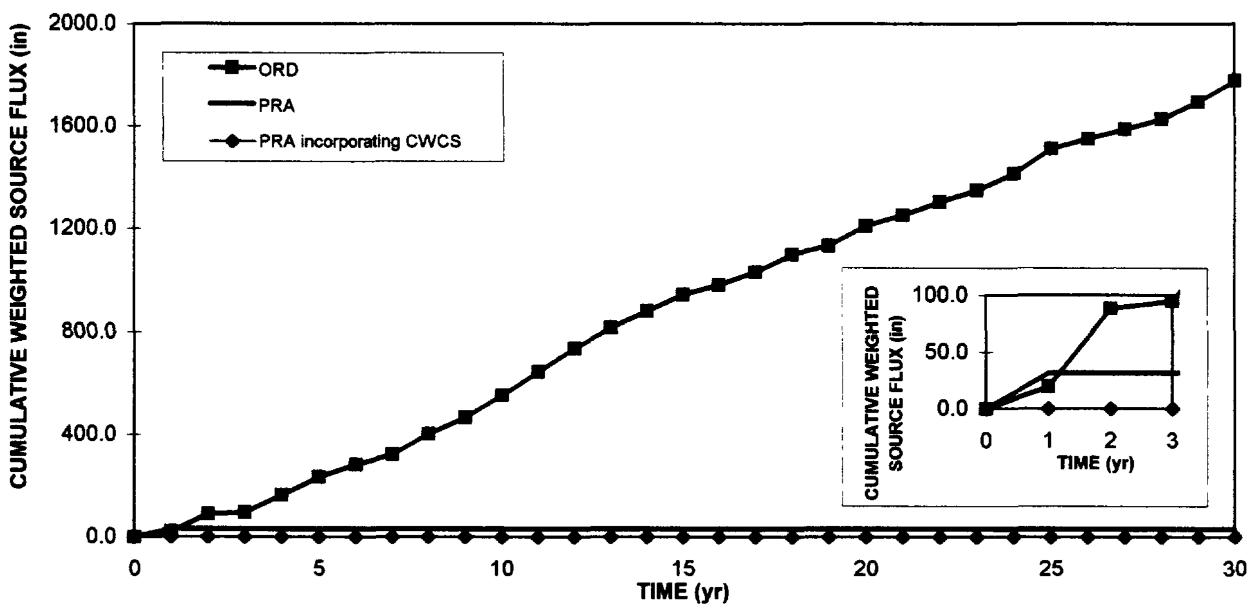
GEOSYNTEC CONSULTANTS
ATLANTA, GEORGIA

FIGURE NO.	8 - 4
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	TIME.CDR

TIME HISTORY OF WEIGHTED SOURCE FLUX
RUBBER CRUMB



Notes:
ORD = Original Remedial Design
PRA = Potential Remedial Alternative
CWCS = Consolidation Water Collection System



Notes:
ORD = Original Remedial Design
PRA = Potential Remedial Alternative
CWCS = Consolidation Water Collection System

GEOSYNTEC CONSULTANTS
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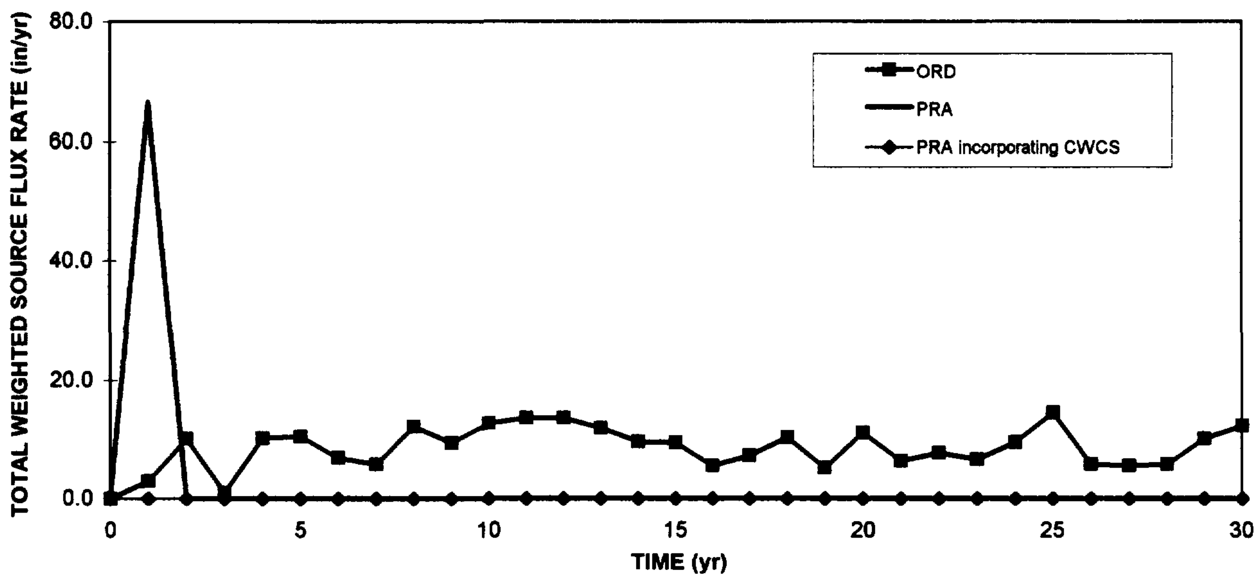
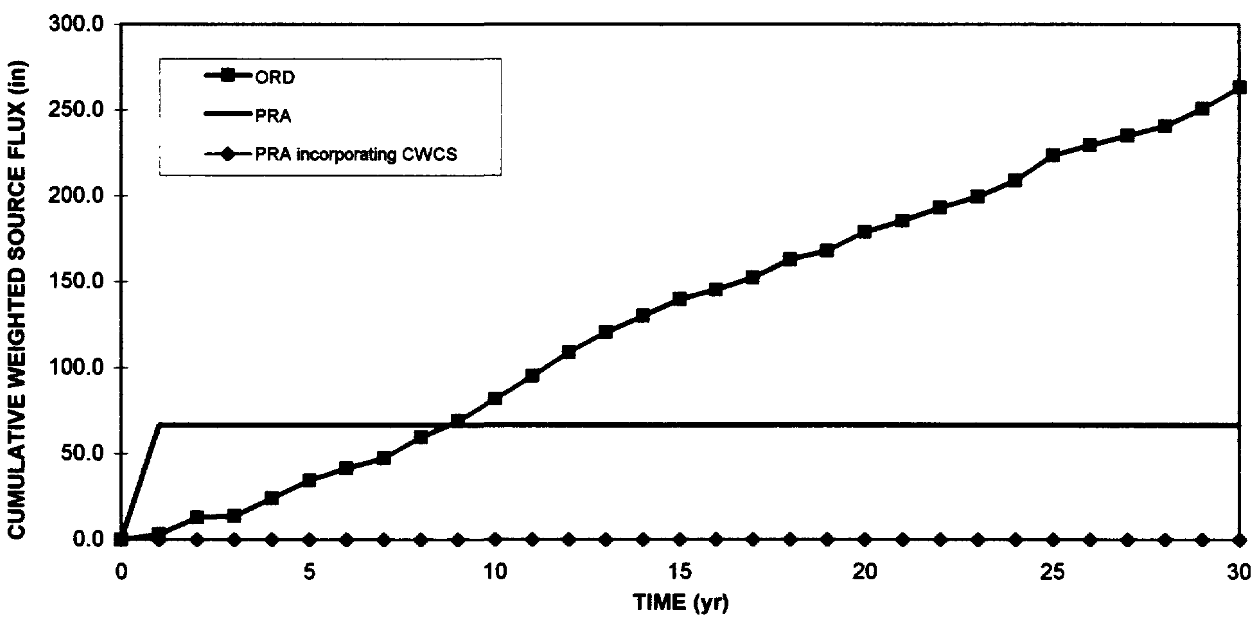
FIGURE NO.	8 - 5
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	TIME.CDR

TIME HISTORY OF WEIGHTED SOURCE FLUX
MSW/RUBBER CRUMB/SOIL



Notes:
ORD = Original Remedial Design
PRA = Potential Remedial Alternative
CWCS = Consolidation Water Collection System



Notes:
ORD = Original Remedial Design
PRA = Potential Remedial Alternative
CWCS = Consolidation Water Collection System

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FIGURE NO.	8 - 6
PROJECT NO.	GE3913-10
DOCUMENT NO.	GA951411
FILE NO.	TIME.CDR

9. DEVELOPMENT AND ASSEMBLY OF REMEDIAL ALTERNATIVES

9.1 Overview

This section of the FFSR provides the further development and assembly of an alternative remedial design (ARD) for the Bailey Superfund Site based on the process options retained following the secondary screening process (presented in Section 7) and the preliminary remedial alternative used in the analysis of technical equivalency (presented in Section 8). The ARD developed in this section will be evaluated in Section 10, Detailed Analysis of Remedial Alternative. This section also further develops the original remedial design (ORD) for comparison with the ARD.

9.2 Original Remedial Design

One of the objectives for the FFS is to identify and evaluate remedial alternatives capable of reducing current and/or future human health and environmental impacts to a level equal to or better than the ORD. It is important to note that the single component cap and in-situ solidification of the entire site (i.e., the major components of the ORD) were not retained following the secondary screening activities presented in Section 7 of this document. However, the ORD has been included in the development of the ARD to establish the baseline for comparison.

The ORD for the North Dike Area and East Dike Area of the site includes the following components:

- construction of flood control dikes to protect the site from flooding during implementation of the remedial alternative so that waste materials are not exposed;

- solidification (primarily in-situ) of wastes to provide a subgrade of adequate bearing capacity to support a cap and to reduce the potential for waste migration;

- consolidation of site debris into the area to be capped;

- construction of a single component cap over the solidified waste to limit precipitation infiltration of stormwater runoff into the waste;
- construction of permanent access and perimeter roads;
- installation of stormwater management controls to treat stormwater runoff collected from disturbed areas during construction and divert stormwater runoff from inactive or completed areas of the site to the marsh; and
- construction of a chain link fence around the site and security gate at the site entrance.

The two major components of the ORD are: (i) in-situ solidification of the waste; and (ii) construction of the single component cap over the area. The performance criteria for the waste solidification component of the ORD were based on unconfined compressive strength and hydraulic conductivity of the solidified material. The performance criterion for unconfined compressive strength was established at 25 psi (172 kPa). The solidified waste performance criterion for the hydraulic conductivity of cored samples of the solidified waste was established at 1×10^{-6} cm/s.

The single component cap developed in the ORD was comprised of the following layers (from bottom to top):

- graded general fill (up to 2.0 ft (0.6 m) thick) to provide a slight slope to the cap for stormwater control;
- a 2.5-ft (0.76-m) thick compacted clay layer to limit surface water infiltration with a hydraulic conductivity of not more than 1×10^{-7} cm/s; and
- a 0.5-ft (0.15-m) thick topsoil layer to support vegetation and protect the cover.

9.3 Alternative Remedial Design - Sitewide Lightweight Composite Cap, Consolidation Water Collection System, and Local "Hot Spot" Remediation

This remedial alternative has been assembled using: (i) previously constructed elements of the original remedial design; (ii) retained elements of the ORD (with possible modifications) that have not yet been constructed; (iii) the lightweight composite cap retained from the secondary screening; (iv) consolidation water collection and removal system; and (v) retained process options for isolated "hot spot" areas. This remedial alternative consists of the components described below.

General Site Construction

The following components are general construction activities to be performed as a part of the ARD:

- consolidation of site debris and cleared vegetation into areas that will be capped;
- installation of a consolidation water collection system to intercept and remove ground water that rises in the short term (i.e., during the construction of the cap) due to the consolidation of the waste; this water will be treated using the on-site treatment facility;
- installation of stormwater management controls to treat stormwater runoff from disturbed areas during construction and divert stormwater runoff from inactive or completed areas of the site to the marsh;
- grading of both the previously solidified area and the unsolidified area using general fill to provide a slight slope to the cap for stormwater control; and
- construction of permanent access roads.

East Dike Area

Components of the ARD specific to the East Dike Area include:

- modification of previously constructed flood control dikes (modifications will include adjustment of top elevations, repair/modifications of areas that have experienced excessive settlement or failure, and erosion/slope protection); and

- construction of a lightweight composite cap and related appurtenances over both the previously solidified and unsolidified areas of waste.

North Dike Area

Components of the ARD specific to the North Dike Area include:

- modifications to the existing dikes and side slopes (i.e., adjustment of top elevations as necessary to tie into the cap, and erosion protection); and

- construction of a lightweight composite cap and related appurtenances over areas of waste.

Local "Hot Spot" Remediation

If an isolated "hot spot" area is identified before or during the revised remedial action, the selection of a remedy for this area would be addressed as a preliminary remedial design activity or as a remedial action activity. In general, "hot spot" areas of the site have been addressed as interim actions during the conduct of the FFS. Therefore, the likelihood of identifying additional "hot spots" at the Bailey Superfund Site is considered low. The types of "hot spots" that could conceivably be discovered include localized soft zones of the site that may exist as a result of the disposal of low strength wastes (e.g., tars, oils, or other liquids). If such an area is encountered, the remedial design for this area would then be developed as follows:

- implement an investigation to: (i) estimate the total volume of waste and affected soils; and (ii) characterize the waste physically and chemically;

- evaluate the process options retained from the secondary screening in Section 7 of this FFSR and those process options that satisfy the requirement of technical equivalency, using the USEPA nine-point criteria [USEPA, 1988b];

- prepare and submit a technical memorandum or letter to USEPA that would recommend a remedial alternative for the "hot spot" area; and

- develop a design for the "hot spot" area concurrently with the remedial design for the other areas of the site or as a remedial action activity.

Major Components of the Selected Remedial Alternative

The major components of the ARD include the construction of a lightweight composite cap over the waste; and (ii) construction and operation of a consolidation water collection and removal system during the construction period. The lightweight composite cap would be comprised of the following layers (from bottom to top):

- graded general fill (up to 2.0 ft (0.6 m) thick) to provide a uniform surface for the geosynthetics and to provide a slight slope to the cap for stormwater control;

- a geogrid reinforcement layer (if required) placed within the general fill material as reinforcement to strengthen the cap in areas where the subgrade has low bearing capacity;

- a GCL to provide a low hydraulic conductivity layer;

- a geomembrane to protect the GCL and to provide an essentially impermeable composite barrier;

- a geocomposite drainage layer to limit the potential for hydraulic head buildup on the composite cap by providing a layer of relatively high hydraulic transmissivity for lateral drainage;

- a protective cover soil layer approximately 0.75 to 1.0 ft (0.2 to 0.3 m) thick to protect the geosynthetic layers from ultra-violet radiation and temperature extremes; and

- vegetation layer (selected grasses) to limit erosion of the protective soil layer.

The consolidation water collection layer would be installed before the placement of the general fill layer and consist of a series of perforated pipes placed in the bottoms of gravel-filled collection trenches. The perforated pipes, which would be installed at or slightly above the ground-water table, would convey consolidation water to collection sumps. This water would then be pumped to the existing wastewater holding tank, treated to the current discharge limits, if necessary, and discharged. After placement of the general fill layer and prior to the placement of the remaining cap components, the sumps would be removed and backfilled with general fill.

10. DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

10.1 Overview

This section of the FFSR presents a detailed analysis of the original remedial design (ORD) and the alternative remedial design (ARD) developed in Section 9 of this document. The detailed analysis of the ORD and ARD was performed using criteria established by USEPA. The criteria for the detailed analysis and the results of the analysis are presented in the following sections. The detailed analysis was conducted as a two-step process. First, each design was analyzed individually using the USEPA nine-point criteria. Second, a comparative analysis was performed to evaluate the relative performance of the alternatives in relation to one another with respect to each evaluation criterion.

10.2 Detailed Analysis Criteria

The ORD and ARD developed for the Bailey Superfund Site were analyzed using criteria established in the "*Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*" (RI/FS Guidance) [USEPA, 1988], and "*Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*" [USEPA, 1993]. The criteria for the detailed analysis, as described in RI/FS Guidance, are as follows.

Threshold Criteria

According to the RI/FS Guidance, these criteria relate directly to statutory findings that must ultimately be made in the ROD.

- Overall Protection of Human Health and the Environment - The assessment for this criterion describes how the alternative, as a whole, achieves and maintains protection of human health and the environment.

- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) - The assessment for this criterion describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered."

Balancing Criteria

Balancing criteria represent the primary criteria upon which the detailed analysis is based.

- Long-Term Effectiveness and Permanence - The assessment of alternatives for this criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met.

- Reduction of Toxicity, Mobility, and Volume Through Treatment - The assessment for this criterion evaluates the anticipated performance of the specific treatment technologies that an alternative may employ.

- Short-Term Effectiveness - The assessment for this criterion examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation of a remedy until the remedial action objectives have been met.

- Implementability - This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services.

- Cost - This assessment evaluates the capital and operation and maintenance (O&M) costs of each alternative.

Modifying Criteria

These final two criteria will be formally evaluated by USEPA following completion of the FFS report.

- State (Support Agency) Acceptance - This assessment evaluates the technical and administrative issues and concerns the state (or support agency) may have regarding each of the alternatives.

- Community Acceptance - This assessment evaluates the issues and concerns the public may have regarding each of the alternatives.

10.3 Individual Analysis of Original Remedial Design

10.3.1 Description of Alternative

A detailed description of the ORD is presented in Section 9.2. An evaluation of this remedial design, as developed by HLA and subsequently approved by USEPA, is presented below.

10.3.2 Overall Protection of Human Health and the Environment

The baseline risk assessment, conducted as part of the RI, concluded that migration of waste constituents from the site has not occurred. In summarizing the RI risk assessment, WCC [1987] states that *"surface water has not been affected at the site by surface runoff or through the embankments of the waste channel. Modeling conducted as part of the RI concludes that the surface water is not likely to be affected for many years in the future under current conditions. Therefore, remediation of the site is directed toward source control."*

The potential pathways of exposure, as specified in the RI risk assessment, are summarized as follows:

- direct contact with surficial waste;

- future ingestion of ground water (assuming ground water becomes affected at a future time);

- consumption of fish or other estuarine life impacted by direct contact with surficial waste;
- surface-water contamination from site runoff (assuming surface runoff becomes affected at a future time); and
- surface-water contamination from horizontal migration through the embankments of the dikes.

If implemented, the ORD would effectively isolate the waste and prevent direct contact by humans and wildlife with surficial wastes. Solidification of the wastes would reduce the mobility of some waste constituents. However, as indicated in the analysis of technical equivalency presented in Section 8, the single component cap would not completely eliminate infiltration of water into the waste during the anticipated life of the cap. As a result of the infiltration through the cap, constituents of concern could be mobilized from the solidified waste, as evidenced by TCLP results presented in the FS report and SER. However, there is no evidence to suggest that waste constituents have migrated from the site via a ground-water pathway.

Implementation of the ORD would provide additional protection compared to existing conditions, by eliminating the direct contact and stormwater runoff exposure pathways. There would also be no opportunity for uptake of isolated wastes into biota and therefore no creation of consumptive exposure pathways.

During the implementation of the ORD, the atmospheric release of volatile organics and particulates would occur due to waste disturbance, solidification activities, and general earth moving activities. Air monitoring would be required, and control measures would have to be implemented to provide worker and community protection during implementation.

10.3.3 Compliance with ARARs

As shown in the RI report, ground water and surface water in the vicinity of the site have not been affected by waste constituents identified at the Bailey Superfund Site. Therefore, ARARs for drinking water and surface water are not relevant or applicable.

Based on the risk assessment developed in the RI report, the ambient water quality criteria of the Clean Water Act are also met.

Air monitoring conducted during RI field activities detected minimal ambient air emissions at the site. Short-term ambient air emissions are expected during implementation of the remedial alternative. Ambient air monitoring of volatiles and particulates would be necessary during excavation, solidification, and cap construction activities to comply with occupational health and safety standards and provide worker protection.

RCRA and state regulations governing capping and construction of landfills are relevant to the Bailey Superfund Site. The ORD also includes the construction of temporary dikes to protect the waste from washout in the event of a catastrophic flood during the construction period.

10.3.4 Long-Term Effectiveness and Performance

Solidification of waste is typically effective at reducing the mobility of inorganic compounds such as metals in soils and sludges. Studies performed during the FS and RD concluded that the mobility of most constituents of concern could be reduced through solidification based on comparison of TCLP testing results of unsolidified and solidified waste samples. However, as described in Section 2 of this FFSR, the waste samples used in these studies were not representative of the waste in-situ since they were collected from drilling activities (i.e., large pieces of debris and other waste materials were excluded from the samples). Therefore, the studies performed during the evaluation and development of the ORD may not be representative of the true long-term effectiveness and performance of the ORD, and may only be indicative of an unquantified improvement over existing conditions.

The single component cap would prevent direct contact by humans, wildlife, and storm water. The low hydraulic conductivity of the compacted clay layer would limit infiltration of precipitation. The cap would be graded to promote and control storm water, thus reducing the amount of water available for infiltration. The cap would need to be maintained to prevent desiccation and/or settlement cracking, penetration by plant roots, or erosion which would decrease the integrity of the clay layer. Based on the relative thinness (0.6 in. (15 mm)) of the topsoil layer above the compacted clay, the climate at the site, and lack of a geomembrane over the compacted clay layer, it is likely that the hydraulic conductivity of the compacted clay layer will increase due to desiccation. Data obtained and references cited in the analysis of technical equivalency in Section 8 of this FFSR support this concern. Therefore, significant maintenance and repair would be required to reduce degradation of the cap; however, it is unlikely that these maintenance activities could fully eliminate the potential effects of desiccation. Since the clay layer is likely to degrade over time, the effectiveness of this alternative will decrease over time and may not provide adequate source control.

10.3.5 Reduction in Toxicity, Mobility, and Volume through Treatment

As shown in the FS report and SER, TCLP testing results for the unsolidified and solidified waste samples indicate that the mobility of some constituents and toxicity of leachate from the waste samples are reduced by solidifying the waste (when compared to existing conditions). It should be noted that the toxicity of the waste is not reduced by solidification.

10.3.6 Short-Term Effectiveness

In the short term (i.e., during construction), measures would need to be implemented to limit worker exposure by direct contact with waste and fugitive emissions of volatile organics and particulates. Control measures including (i) dust suppression; (ii) use of appropriate personal protection equipment; and (iii) equipment and personnel decontamination facilities should be effective in limiting exposure. These control measures, together with perimeter air monitoring, would provide adequate protection to the community during implementation.

Stormwater runoff would also need to be collected from disturbed areas and treated to limit surface-water contamination from site runoff during construction. Based on the production rates achieved by earlier attempts to implement the ORD, the time required to implement the solidification component of the remedy is considered to be excessive.

There will be increased risk to workers and the environment during implementation of the ORD. However, these risks are considered relatively low and can be managed by conventional means.

10.3.7 Implementability

GeoSyntec has performed supplemental investigations into the North Dike Area and East Dike Area of the site. The results of these investigations are presented and discussed in Appendices A and B of this report, respectively. Based on the volume, composition, heterogeneity, and organic content of the waste, GeoSyntec has concluded that successful in-situ solidification of the waste to the specified performance criteria is technically infeasible, except for the southern-middle portion of the East Dike Area where it may be possible to solidify the waste assuming the sampling methodology and acceptance criteria are modified. Successful implementation of the in-situ solidification remedy for the remainder of the site would be difficult or impracticable to implement using cost effective and reliable construction techniques. Construction of the single composite cap is considered implementable.

10.3.8 Cost

Table 10-1 presents the rough order-of-magnitude (ROM) cost estimate for both capital and O&M costs for the implementation and maintenance of the ORD. Capital costs are based on the bids obtained for the original remedial action, and have been adjusted to account for: (i) additional items of work identified during the original remedial action; (ii) increases in quantities and unit rates that were identified during the original remedial action; and (iii) increases in construction price indices from the original bid date to 1996. The estimated costs for the ORD therefore represent the ROM cost estimate for implementing the ORD during 1996, and are updated from original costs using information obtained since the ORD was originally bid.

10.3.9 State Acceptance

The ORD was approved by USEPA and accepted by the Texas Natural Resources Conservation Commission.

10.3.10 Community Acceptance

The ORD was accepted by the community.

10.4 Alternative Remedial Design - Sitewide Lightweight Composite Cap, Consolidation Water Collection System, and Local "Hot Spot" Remediation

10.4.1 Description of Alternative

A detailed description of the ARD is presented in Section 9.2. This alternative includes the construction of a lightweight cap over areas of the site that contain waste and the construction and operation of a consolidation water collection and removal system during the construction period. The detailed analysis presented in the following sections of this FFSR does not address process options for local "hot spot" remediation. As previously discussed, the major "hot spot" areas of the site have been addressed as interim actions during conduct of the FFS, and the likelihood of discovering additional "hot spots" at the Bailey Superfund Site is considered low. Any process options ultimately recommended for local "hot spot" areas will satisfy the: (i) requirement for technical equivalency; and (ii) USEPA nine-point criteria.

10.4.2 Overall Protection of Human Health and the Environment

As stated in Section 10.3.2, the RI report indicates that migration of waste constituents from the site has not occurred. In addition, there is no evidence to suggest that waste constituents have migrated from the site via a ground-water pathway.

If implemented, the ARD would effectively isolate waste and prevent direct contact by humans and wildlife with surficial wastes. As presented in the analysis of technical equivalency in Section 8, the lightweight composite cap will essentially eliminate infiltration, but the load of the general fill and protective cover soil will result in consolidation of the waste and production of consolidation water. As previously stated, this consolidation water will be collected, removed, treated, and discharged; therefore, the effects from production of these liquids should be negligible. Based on the analyses presented and observations made during the SPDS, the consolidation process should occur within a relatively short period of time (i.e., during the construction period or shortly thereafter), and continuation of existing surface-water management measures during implementation of the ARD will increase the short-term performance of the ARD.

Implementation of the ARD would provide additional protection compared to existing conditions by: (i) eliminating the direct contact exposure pathway; (ii) eliminating the stormwater runoff exposure pathway; and (iii) limiting the generation and release of leachable liquids from the waste and therefore protecting the ground-water pathway. There would also be no opportunity for uptake of isolated wastes into biota and therefore no creation of consumptive exposure pathways.

During the implementation of this alternative, the atmospheric release of volatile organics and particulates would occur due to waste disturbance and general earthmoving activities. Air monitoring would be required, and control measures may have to be implemented to provide worker and community protection during implementation.

10.4.3 Compliance with ARARs

As shown in the RI, ground water and surface water in the vicinity of the site have not been affected by waste constituents identified at the Bailey Superfund Site. Therefore, ARARs for drinking water and surface water are not relevant or applicable. Based on the risk assessment developed in the RI report, the ambient water quality criteria of the Clean Water Act are also met.

Air monitoring conducted during RI field activities detected minimal ambient air emissions at the site. Short-term ambient air emissions are expected during implementation of the ARD. Ambient air monitoring of volatiles and particulates would be necessary during excavation and cap construction activities to comply with occupational health and safety standards and provide worker protection.

The lightweight composite cap would be designed to meet the substantive guidance of USEPA for a RCRA Subtitle C facility [USEPA, 1991]. The consolidation water collection and removal system would be operated such that existing treatment standards for the wastewater treatment system are attained.

10.4.4 Long-Term Effectiveness and Performance

Lightweight composite caps are very effective at limiting infiltration and preventing direct exposure of humans and wildlife to the waste. The incorporation of a HDPE geomembrane into the capping system provides protection to underlying components from the effects of desiccation, thus reducing degradation of the cap over time. Modeling of the cap using the HELP computer program predicts infiltration through the cap to be negligible. Since the cap will significantly reduce infiltration, will not appreciably degrade over time, and will not induce significant long-term consolidation effects, the ARD provides long-term effectiveness and performance.

10.4.5 Reduction in Toxicity, Mobility, and Volume through Treatment

The ARD does not include treatment of the waste mass, but does include the collection, removal, and treatment of consolidation water during the construction period. As described in Section 8, the installation of a consolidation water collection system and continuation of existing surface-water management measures during remedy implementation will mitigate the potential effects of mobilizing waste constituents in the short-term and will result in a decrease in the total volume of waste due to removal of consolidation water from the waste mass. Mobility of waste constituents is significantly reduced in the long term by source control since infiltration into the waste is essentially eliminated. The volume of the waste would be reduced by an estimated 4 to 12 percent due to consolidation of the waste under the imposed load of the cap.

10.4.6 Short-Term Effectiveness

In the short term (i.e., during construction), measures would need to be implemented to limit worker exposure by direct contact with waste and fugitive emissions of volatile organics and particulates. Control measures including (i) dust suppression; (ii) use of appropriate personal protection equipment; and (iii) equipment and personnel decontamination facilities should be effective in limiting exposure. These control measures, together with perimeter air monitoring, would provide adequate protection to the community during implementation.

There would be a short-term increase in the mobility of waste constituents due to consolidation of the waste under the imposed load of the cap and the related consolidation water. However, installation of a consolidation water collection system and continuation of existing surface-water management measures during remedy implementation will mitigate these effects.

Stormwater runoff would also need to be collected from disturbed areas and treated to limit surface-water contamination from site runoff.

The time required to implement this alternative is estimated to be approximately one year. There will be a limited increased risk to workers and the environment during the implementation of this alternative. However, these risks are considered relatively low and can be managed by conventional means.

10.4.7 Implementability

The lightweight composite cap and consolidation water collection and removal system can be implemented using conventional equipment and readily available materials. Although the solidification component was partially included in the ORD to support the weight of a cap, the waste at the Bailey Superfund Site has more than adequate strength to support the proposed lightweight composite cap. This conclusion is based on observations made during the supplemental site investigations performed as part of the focused feasibility study (FFS) and remedial activities associated with the North Marsh Area and Pit B. The following observations were made with respect to the strength of the waste in the North Dike Area and East Dike Area and its ability to support the cap: (i) the waste is capable of supporting heavy construction equipment (e.g., track hoes, end dumps, loaders, and dozers) and other construction related surface loads (e.g., water storage tanks, water treatment plant, waste storage pad, and soil and aggregate stockpiles); (ii) the waste is comprised of a mixture of intermingled small and large particles and debris; these components provide the waste with significant strength and make it relatively dense (i.e., lacking large void spaces); (iii) in general, the walls of test pits excavated in the waste did not collapse during the excavation activities; and (iv) the waste can be difficult to excavate due to the quantity of large debris and presence of relatively hard rubber crumb.

Further evidence of the ability of the waste to support a lightweight composite cap is given by the following results of the SPDS:

- all five test pads exhibited a high degree of stability;
- average amount of consolidation for the five pads during the evaluation period was 3.24 in. (82.3 mm); and
- the rate of consolidation rapidly decreases with time.

Therefore, the anticipated settlements and corresponding strains induced in the cap components can be accommodated using conventional design techniques and construction materials. The uncertainties associated with this approach can be managed, and are best addressed as design issues.

The use of lightweight composite caps is well established as a reliable process option for source control. Since the ARD is a source control remedy, and is not fundamentally different to the original remedial design in terms of performance, implementation of this alternative may only require the preparation of an ESD on the part of USEPA. If an ESD cannot be prepared, USEPA would need to issue a ROD amendment.

10.4.8 Cost

Table 10-2 presents a ROM cost estimate for the ARD.

10.4.9 State Acceptance

In accordance with USEPA guidance, this criterion will be addressed following completion of the FFS.

10.4.10 Community Acceptance

In accordance with USEPA guidance, this criterion will be addressed following completion of the FFS.

10.5 Comparative Analysis of Alternatives

10.5.1 Overall Protection of Human Health and the Environment

If implemented, either alternative would effectively isolate the waste, prevent direct contact by humans and wildlife with surficial wastes, and provide a degree of source control. Based on the results of the analysis of technical equivalency in Section 8, the ARD would provide a greater degree of protection to human health and the environment than the ORD over the anticipated lifetime of the remedy. A higher degree of source control is achieved due to the low hydraulic conductivity of the lightweight composite cap as compared to the single component cap. Although the unsolidified waste (ARD) has a greater potential for leaching constituents of concern than the solidified waste of the ORD, the lower hydraulic conductivity of the cap would result in essentially no infiltration into the waste mass.

During implementation, the ARD would result in less risk to workers than the ORD, since it would involve less disturbance of waste materials (i.e., the solidification component of the ORD would involve disturbance of the waste and result in a greater release of volatile organics and particulates).

In the short term (i.e., during construction), performance of the ARD (in terms of source containment) is superior to that of the ORD assuming that a consolidation water collection system is installed, construction is properly sequenced, and existing surface-water management measures are continued during implementation of the ARD.

Based on consideration of the anticipated short-term and long-term risks, and the likely impact on existing conditions, the ARD is considered to be better than the ORD in protecting human health and the environment.

10.5.2 Compliance with ARARs

The ARD would be designed using a lightweight composite cap that meets state regulations and the substantive recommendations of USEPA for a RCRA Subtitle C facility [USEPA, 1991]. Since the ARD would involve negligible disturbance of waste materials, temporary flood control dikes required during the implementation of the ORD would not be required for the ARD. The consolidation water collection and removal system will require continued operation of the existing on-site wastewater treatment system during the construction period. Treatment and discharge of treated water would be performed in accordance with existing site procedures.

Implementation of either the ORD or the ARD would require compliance with occupational health and safety protection standards. Since implementation of the ARD would involve less disturbance of waste, this alternative involves a lower potential for worker exposure.

10.5.3 Long-Term Effectiveness and Performance

The ARD provides better long-term effectiveness and performance than the ORD based on the results of the analysis of technical equivalency in Section 8.

10.5.4 Reduction in Toxicity, Mobility, and Volume through Treatment

The solidification component of the ORD would result in a decrease in the toxicity of the leachate released from the waste material, whereas the ARD would have no effect on toxicity. In the ORD, the mobility of waste constituents would be reduced by the solidification component and by the single component cap (by limiting infiltration). Similarly, in the ARD, the mobility of waste constituents would be reduced by the lightweight composite cap. Although the lightweight composite cap would provide better source control (i.e., has a lower hydraulic conductivity), the imposed load due to the weight of the cap would result in a short-term increase in mobility of waste constituents due to the production of consolidation water. However, the installation of a consolidation water collection system and continuation of existing surface-water management measures during remedy implementation will mitigate these effects and result in the superior performance of the ARD when compared to the ORD. Since the ARD provides superior performance in terms of source control, the mobility of the waste constituents is lower for the ARD in the long term.

The volume of waste would be slightly reduced by the implementation of the ARD (due to consolidation of the waste). Implementation of the ORD would result in a slight increase in the volume of waste due to the addition of solidification admixtures. The ARD, therefore, better meets the criterion of reduction in toxicity, mobility, and volume.

10.5.5 Short-Term Effectiveness

Implementation of either alternative will require measures to limit direct exposure of workers to waste and fugitive emissions. The ARD would require less disturbance of waste and therefore results in the lowest risk.

Both alternatives require collection of stormwater runoff from disturbed areas and treatment to limit surface-water contamination from site runoff during construction. The ARD may result in less waste disturbance and, hence, less potential for contamination of surface water.

Implementation of the ORD would result in an immediate reduction in the mobility of wastes, whereas implementation of the ARD would result in a short-term increase in mobility of waste constituents due to consolidation effects and associated consolidation water. However, the installation of a consolidation water collection system and continuation of existing surface-water management during remedy implementation will mitigate these effects and result in superior performance of the ARD when compared to the ORD. Also, this increase in mobility is not considered significant, since there is evidence to suggest that under the existing hydrogeological conditions, site constituents have not migrated, and should not migrate, via a ground-water pathway.

Neither alternative would result in unacceptable risk to the community during implementation. Air monitoring would be performed to monitor for the presence of fugitive emissions.

The ARD better meets the criterion of short-term effectiveness, since there is no risk associated with the increased mobility of waste constituents and the ORD would increase short-term risks to site workers.

10.5.6 Implementability

The ARD is considered more implementable since: (i) the ARD utilizes conventional construction equipment and materials; and (ii) the solidification component of the ORD to the specified performance criteria is considered to be technically infeasible for the major portions of the site. Successful implementation of the in-situ solidification component would be difficult or impracticable to implement using cost effective and reliable construction techniques. Uncertainties associated with the implementation of the ARD are considered manageable and can be addressed as design issues.

10.5.7 Cost

Implementation of the ARD will result in lower capital costs than would implementation of the ORD. O&M costs associated with the ARD would be lower, because the lightweight composite cap will require less maintenance and repair due to desiccation than the single component cap. Therefore, the ARD has an overall lower cost than the ORD.

10.5.8 State Acceptance

In accordance with USEPA guidance, this criterion will be addressed following completion of the FFS.

10.5.9 Community Acceptance

In accordance with USEPA guidance, this criterion will be addressed following completion of the FFS.

10.6 Documentation of ARARs

In accordance with USEPA guidance, the applicable or relevant and appropriate requirements (ARARs) referenced in the detailed analysis of alternatives are provided below:

- 40 CFR 264.18(b) (RCRA) - Facilities in 100-year floodplains must be designed, constructed, operated and maintained to avoid washout.
- Executive Order 11988 (Floodplain Management) - Action taken must avoid adverse effects and minimize potential harm to the surrounding area.
- 40 CFR 264 (RCRA) - Construction requirements for hazardous waste storage facilities.
- 29 CFR 1910 (Occupational Health and Safety Act) - Protection standards for workers.

10.7 Summary

The detailed analysis of the alternatives indicates that the ARD performs better than the ORD when evaluated against the USEPA nine-point criteria. The ARD is equally or more protective to human health and the environment and is therefore recommended as the basis for development of a revised remedial action at the Bailey Superfund Site.

TABLE 10-1
PRELIMINARY COST ESTIMATE–ORIGINAL REMEDIAL DESIGN
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Cost Category	Category Total ($)
Mobilization/Demobilization	783,120.33
Security	89,721.99
Site Preparation/Grading	166,531.64
Drum Storage Area	14,116.18
Dike Work	2,036,529.10
Roadwork	287,780.08
Geosynthetic Reinforcement and Ground Improvements	1,269,566.55
Waste Solidification	2,590,525.78
Stormwater Control/Slope Protection	1,097,073.34
Water Treatment	442,225.10
Single Component Cap	1,275,536.83
Surveying	6,535.27
Plug Wells	67,842.32
Sample Activities	45,155.60
EPA Oversight	787,853.73
Additional Construction	6,254,336.10
Miscellaneous	433,350.62
Subtotal	**17,647,800.57**
Engineering	9,958,087.14
Administrative	2,963,421.16
Contingency (25 percent)	4,576,711.77
Total	**35,146,020.64**
Annual Operations and Maintenance	20,500.00
Interest Rate	8%
30 Year Present Worth	**230,785.00**
Total Estimated Cost	**35,376,805.64**

TABLE 10-2
PRELIMINARY COST ESTIMATE–ALTERNATIVE REMEDIAL DESIGN
BAILEY SUPERFUND SITE
ORANGE COUNTY, TEXAS

Category	Category Total ($)
Mobilization/Demobilization	295,643.15
Security	89,721.99
Site Preparation/Grading	166,531.64
Drum Storage Area	14,116.18
Dike Work	637,138.37
Roadwork	287,780.08
Geosynthetic Reinforcement and Ground Improvements	233,402.49
Stormwater Control/Slope Protection	1,097,073.34
Water Treatment	251,613.07
Lightweight Composite Cap	1,811,476.24
Surveying	6,535.27
Plug Wells	67,842.32
Sample Activities	45,155.60
EPA Oversight	259,336.10
Miscellaneous	293,309.13
Subtotal	**5,997,546.36**
Engineering	2,074,688.80
Administrative	489,626.56
Contingency (25 percent)	1555,380.28
Total	**10,117,241.99**
Annual Operations and Maintenance	15,500.00
Interest Rate	0.08
30 Year Present Worth	**174,496.00**
Total Estimated Cost	**10,291,737.99**

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